

# HAWTHORNS (*CRATAEGUS*: ROSACEAE) OF THE CYPRESS HILLS, ALBERTA AND SASKATCHEWAN

J.B. Phipps

Department of Biology  
The University of Western Ontario  
1151 Richmond Street  
London, Ontario, N6A 5B7, CANADA  
jhipps@uwo.ca

R.J. O'Kennon

Botanical Research Institute of Texas  
509 Pecan Street  
Fort Worth, Texas, 76102-4060, U.S.A.  
bokennon@brit.org

## ABSTRACT

This paper describes the ecological situation of *Crataegus* found in the Cypress Hills of Alberta and Saskatchewan in the context of climate and vegetation patterns, followed by a detailed account of the taxa present. *Crataegus* species are shown to be extremely numerous in certain habitats and are by far the most abundant shrubby plant of the Cypress Hills. A peculiar combination of physical factors of relief, temperature, precipitation and soil have given rise to a remarkable ecological island. Thirteen species of *Crataegus* are shown to occur compared with three in earlier work. Seven of the species, *C. cupressocollina*, *C. aquacervensis*, *C. rivuloadamensis*, *C. purpurella*, *C. rivulopugnensis*, *C. rubribracteolata* and *C. ursopedensis* are new to science and most of them are at least locally common in the Cypress Hills. In addition, *C. sheridana* A. Nels. has been resurrected. Also one new variety, *saskatchewanensis*, of *C. sheila-hippsiae* is described. Four of the new taxa appear to be restricted to the Cypress Hills although more intensive fieldwork in Montana might alter this. The biogeography is discussed in the context of Great Plains Holocene vegetation change and the small amount of information available on their differential ecology. All taxa are keyed and the new taxa are each fully described and illustrated. This work is based on over 500 collections, over 450 of which are by the authors.

KEY WORDS: *Crataegus*, Rosaceae, systematics, taxonomy, biogeography, ecology, Cypress Hills, new taxa

## RESUMEN

En este artículo se describe la situación ecológica de *Crataegus* en los Cypress Hills de Alberta y Saskatchewan en el contexto de patrones de clima y vegetación, seguido de un informe detallado de los taxa presentes. Las especies de *Crataegus* son extremadamente numerosas en ciertos hábitats y son con mucho las plantas arbustivas más abundantes de las Cypress Hills. Una combinación peculiar de factores físicos de relieve, temperatura, precipitación y suelo han dado lugar a una isla ecológica singular. Se demuestra la presencia de trece especies de *Crataegus* comparadas con las tres de un trabajo previo. Siete de las especies, *C. cupressocollina*, *C. aquacervensis*, *C. rivuloadamensis*, *C. purpurella*, *C. rivulopugnensis*, *C. rubribracteolata* y *C. ursopedensis* son nuevas para la ciencia y la mayoría de ellas son al menos localmente comunes en las Cypress Hills. Además, *C. sheridana* A. Nels. ha sido resucitada. También se describe una nueva variedad, *saskatchewanensis*, de *C. sheila-hippsiae*. Cuatro de los nuevos taxa parecen restringirse a las Cypress Hills aunque un trabajo de campo más intenso en Montana pudiera alterar esto. Se discute la biogeografía en el contexto del cambio de la vegetación en el Holoceno de las Grandes Llanuras y la poca cantidad de información sobre su ecología diferencial. Todos los taxa se incluyen en la clave y los nuevos taxa se describen ampliamente y se ilustran. Este trabajo está basado en más de 500 colecciones, más de 450 de las cuales fueron realizadas por los autores.

The authors decided to add the Cypress Hills (Plate 1) to their botanical explorations of the western parts of the North American continent and in doing so unearthed a botanical goldmine. This paper describes in detail the thirteen species of *Crataegus* discovered, six species and one variety proving new to science. Not only was there a large number of hawthorn taxa present, as in the British Columbia Okanagan, but the number of individuals, over 500 collections studied as emphasized in Figure 2 (collated points for all species), was very large and thus clearly indicates one of the most favorable areas of similar size for *Crataegus* in the west of the continent. Hawthorns, discovered to be by far the most abundant shrub genus in the Cypress Hills and of great biological significance due not only to this fact, but also, *inter alia*, to their considerable fruit production providing food for numerous species of bird and mammals, nevertheless do not achieve more than passing mention in significant ecological treatments of the area, a situation which is remedied here. Questions were prompted about what was significant about the habitat that was so favorable and this is discussed below. Because the Cypress Hills constitute an ecological island (similar in this respect to several in Montana east of the Rocky Mountains) and because a considerable proportion of the taxa found appeared



to have distributions tied to these ecological islands, it seemed of interest to consider the biogeographic ramifications of the Cypress Hills *Crataegus* populations particularly in the context of the Great Plains Holocene, which is also done. These and related matters form the subject of this paper.

#### PHYSICAL BACKGROUND

The Cypress Hills are a regionally significant landform lying between about 111° W and 108° 40' W and 49° 20' N and 49° 45' N, i.e. in the southern part of the western half of the Canadian Prairie Provinces, thus occupying about 165 km E–W × 60 km N–S or about 10,000 sq. km. Their location is shown on Plate 1. The Cypress Hills are presented in three maps the first of which is a colored relief map with forest cover indicated (Plate 2) followed by a detailed sketch map of the hills broken into eastern and western halves (Figs. 1a, 1b). The Cypress Hills trend east-west and lie between the Canada-United States border, which is to the south, and the Trans-Canada Highway, which is to the north. The topography is gently rolling to almost flat on the summit plateau which has a highest point of 1465 m in the west, nearly due south of Elkwater, Alberta and which descends to levels of only about 1200 m towards the eastern end of the hills in Saskatchewan. The nearly flat-lying prairies at the bottom of the northern scarp lie about 400–600 m below the summit plateau. Along the northern edge of the Cypress Hills is a scarp slope (Fig. 4a), dissected by creeks of various size, some of which eventually reach the South Saskatchewan River. Both eastern and western limits are also quite sharply defined, with a significant eastern scarp from which arise tributaries of Swift Current. Medicine Lodge Coulee (Fig. 4b), a glacial spillway, slices off the western end of the Cypress Hills in Alberta and is a particularly striking topographical feature. From there, Lodge Creek flows southeastwards into the Milk River in Montana. The southern limits of the hills are, contrastingly, much less sharply defined (Fig. 4a, Plate 3c) and fade into high grassland towards Montana. A further important valley, that of Battle Creek, another glacial spillway, originates near the northern scarp in Alberta, thence flowing southeast through Fort Walsh in Saskatchewan before eventually joining the Milk River east of Havre in Montana while a major river, the east-flowing Frenchman, dissects the hills in their south-eastern quadrant.

A considerable variety of flat-lying sedimentary rocks of upper Mesozoic to lower Tertiary (Fig. 3) creates the basis for the generally smooth topography. Some interesting elements include good exposures of the KT boundary clay and upper Cretaceous finds of dinosaurs such as *Tyrannosaurus rex*. Brown chernozem soils are found in grassland below the tree line and dark brown chernozems on the summit plateau while forest slope soils are typically dark grey luvisols (Henderson et al. 2000). However, there is no obvious relationship between underlying geology, resultant soil types and *Crataegus* distribution patterns in the Cypress Hills. Rather, *Crataegus* distribution in the Cypress Hills appears mainly to follow soil moisture patterns.

Indeed, moisture has been shown to be the key determinant of regional vegetation distribution in the southern Canadian Prairies and adjacent United States (Looman 1979; Larsen & MacDonald 1995; Hogg 1994). Hogg (1997) calculated a climatic moisture index (CMI) to which the regional vegetation was more closely tied than to any other factor. Hogg's CMI was calculated as mean annual precipitation minus potential evapotranspiration. He showed CMI's below -30 are for grassland, -30 to -15 (grassland with stunted aspen), -15 to 0 (mixed aspen-grassland), 0 to 15 (aspen dominated woods with conifers) and over 15 (coniferous woodland). The presence of habitats in the Cypress Hills with higher CMI's is the principal reason for the presence of *Crataegus* there so forest cover is shown on the topographical map (Plate 2) although it is somewhat inexactly represented at this scale. The reason for the prevalence of higher CMI's is connected with the combination of lower temperatures with increasing altitude as well as higher precipitation with increasing altitude in parts of the Cypress Hills, a topic which is elaborated in a discussion of the meteorology.

We were not able to draw upon a fine grid of relevant microclimatological data for the Cypress Hills, only one meteorological station being within the hills proper, that at the Cypress Hills Provincial Park HQ, SK. The surrounding prairie stations are, however, quite close by and thus present characteristic regional climatic data which presumably also reflects that for the grassland parts of the Cypress Hills in precipitation if not in temperature. The surrounding prairie stations selected are: Medicine Hat, Alta., 45 km NW of



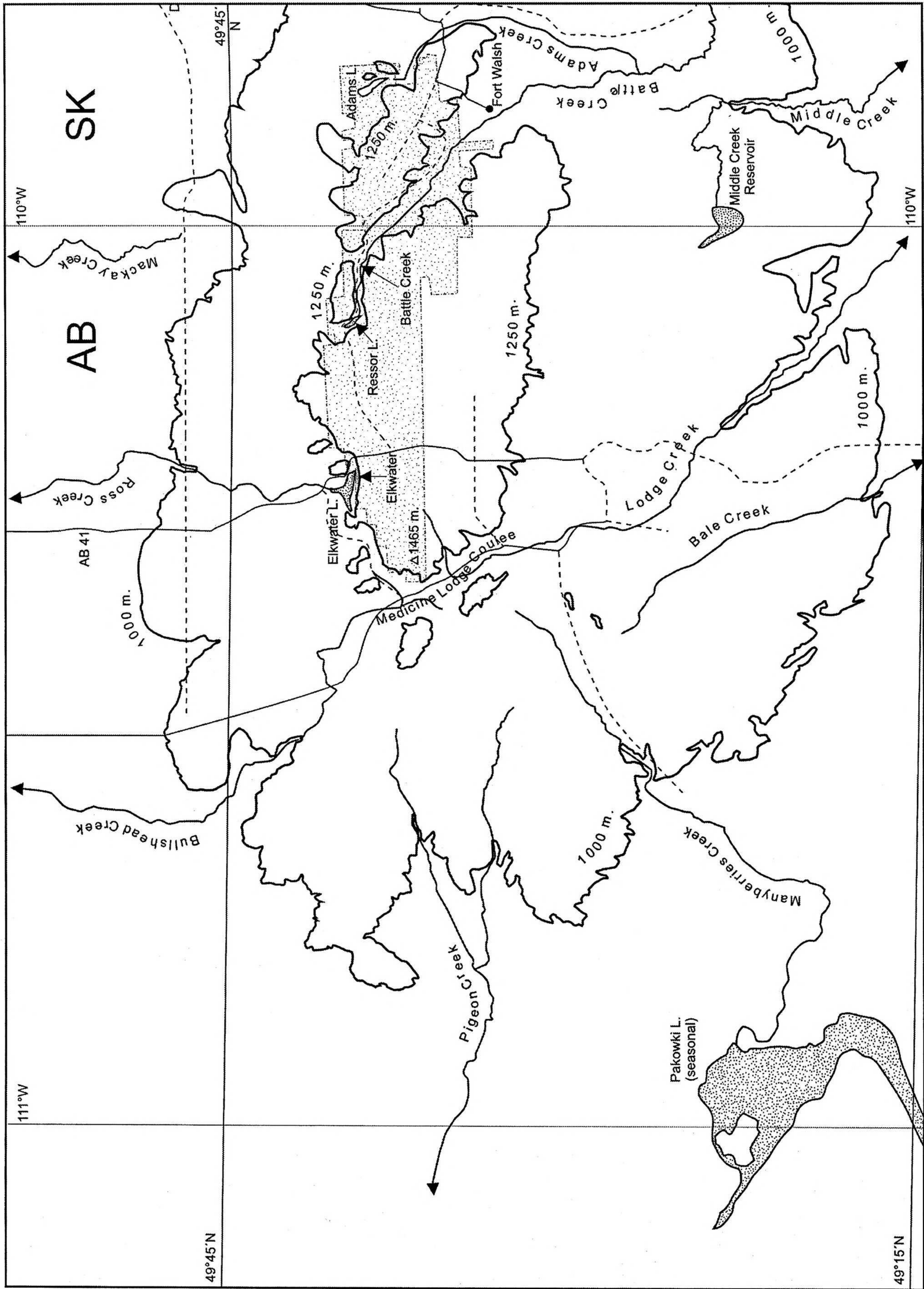


FIG. 1a. Sketch map of Cypress Hills, western part, showing main places mentioned in text. Parks and water bodies stippled; dotted lines are unpaved roads. Scale: 20 km = 52 mm.

Elkwater; Maple Creek, Sask., at the base of the northern slopes of the hills; Shaunavon, Sask., ca. 25 km E of the eastern scarp of the hills; and Willow Creek, Sask., on the Montana border due south of the centre of the hills. These sites thus collectively and usefully box in the Cypress Hills and show the regional prairie climate to be quite uniform.



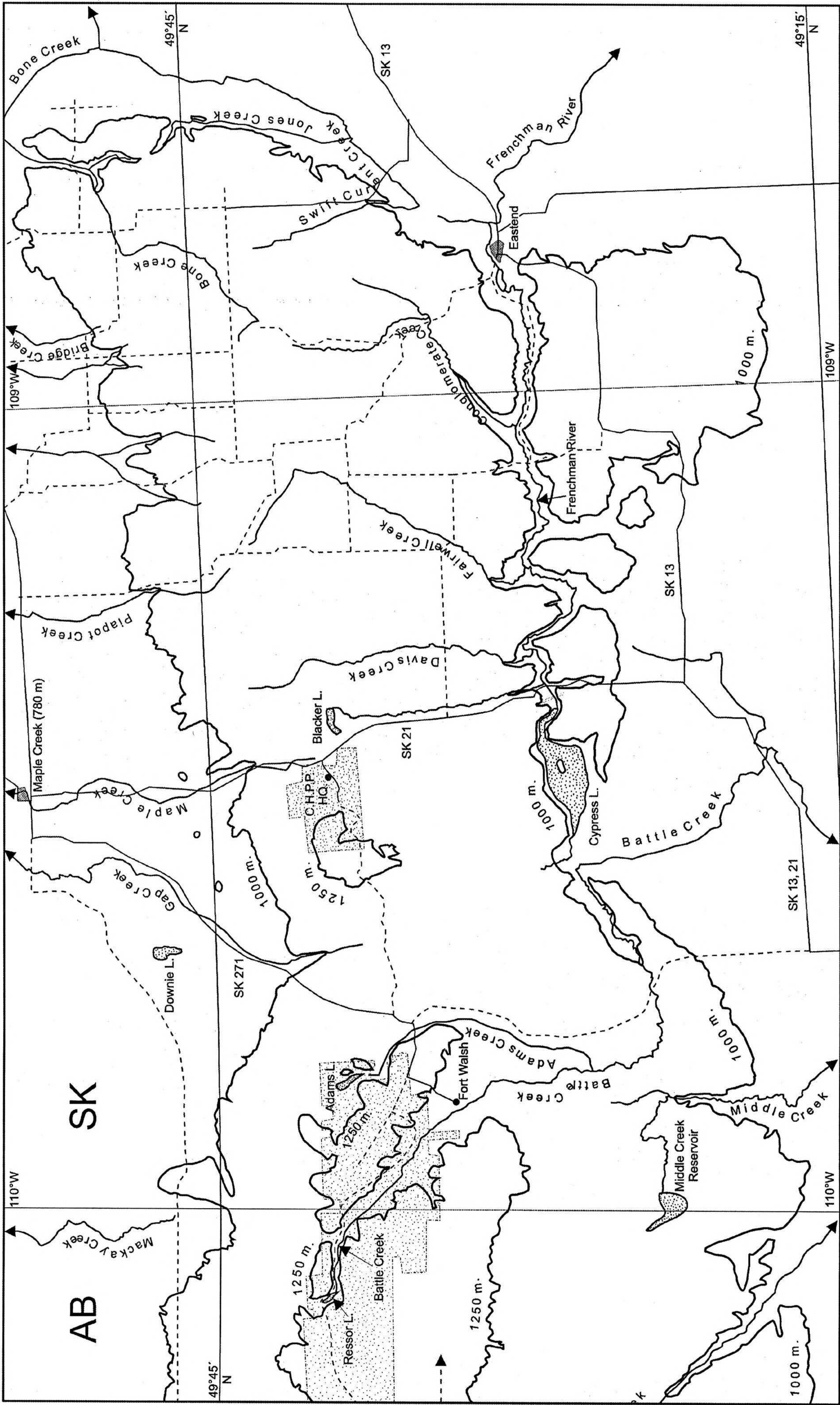


FIG. 1b. Sketch map of Cypress Hills, eastern part, showing main places mentioned in text. Conventions as Fig. 1a.



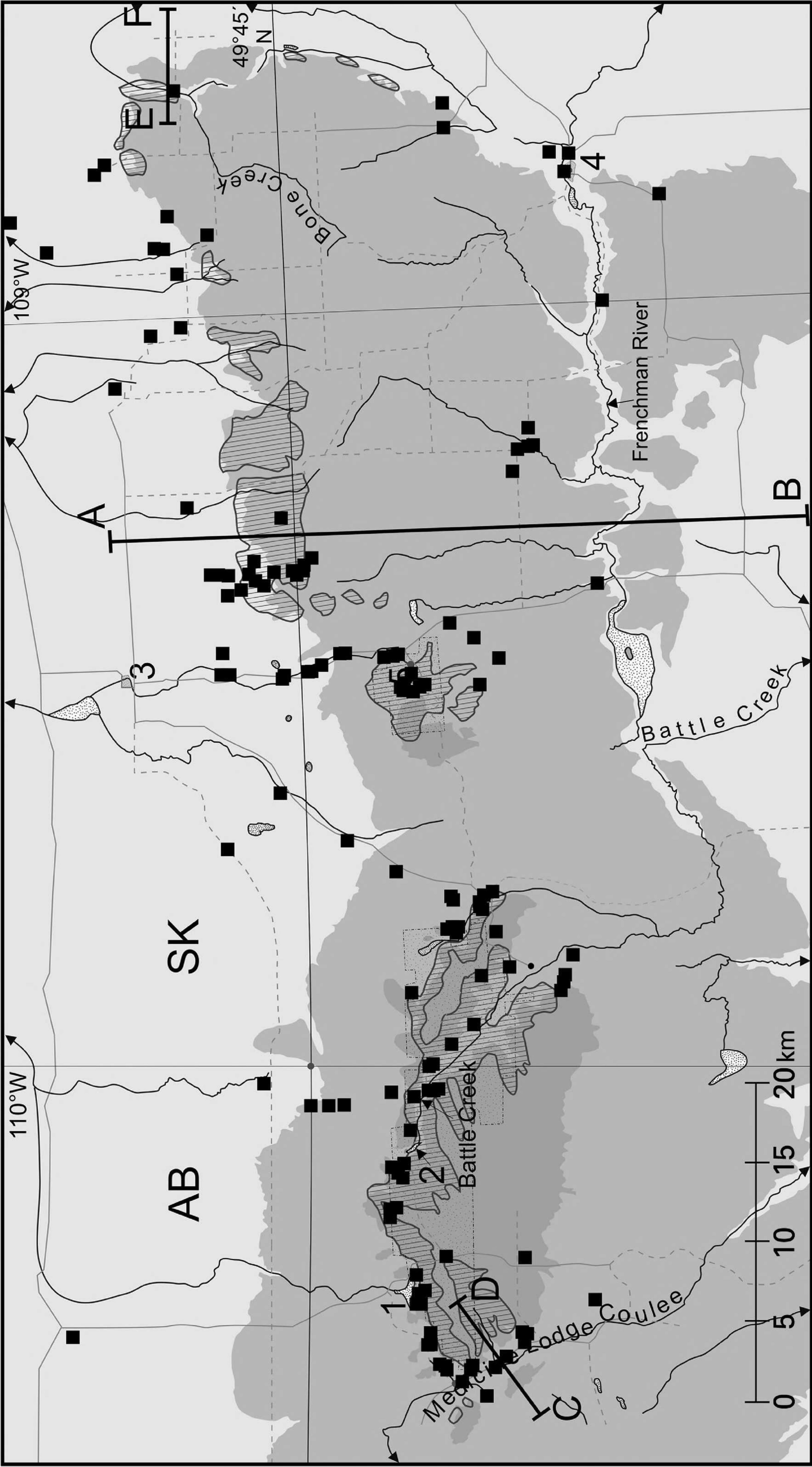


FIG. 2. Map of collated points, all records. Conventions as Plate 2 but in grayscale.



Although an almost complete lack of meteorological stations within the Cypress Hills prevents any precise and detailed interpretation of climatic variation, comparison between Maple Creek, a drier and warmer site at the base of the central part of the northern scarp at 764 m, and Cypress Hills Provincial Park, nestled in a low valley in the central part of the summit plateau almost due south of Maple Creek, and only about 28 km distant, at 1196 m, is instructive. From the mean monthly precipitation and temperatures (Tables 1, 2) for these and other reference stations it may be seen that the area around the Cypress Hills Provincial Park meteorological station is both cooler (mean monthly difference during the growing season from April to October of 3.1 deg. C) and substantially wetter (606 vs. 375 mm annual precipitation), thus ecologically more mesic, than Maple Creek. Maple Creek, in spite of being so close to the hills, is nevertheless typical of the group of regional sites used. All of the latter thus have similar to slightly warmer temperatures and similar to slightly less precipitation than Maple Creek, thus illuminating the island nature of the mesic parts of the Cypress Hills. It is the impact of moisture-laden

cold fronts rising up exposed scarps from the north and northwest that accounts for the unequal distribution of precipitation in the Cypress Hills and altitude for the temperature differential. Growing season snow has twice been encountered during our fieldwork over 20 cm deep on parts of the northern scarp face (Plate 5a).

The effect of altitude on temperature may also be seen by considering anthesis times, as the following example illustrates. In spring 2003 the temperature contrast between Cypress Hills Provincial Park and the Maple Creek meteorological stations translated into one species of *Crataegus* (*C. cupressocollina*) being in full flower on 23 May on the lower slopes of the northern scarp at 892 m, near Maple Creek, as well as in the Frenchman Valley near Eastend at the same date and similar altitude but being still in tight bud (flower buds ca. 2 mm diam., entire inflorescence extension only about 15 mm) near Cypress Hills Provincial Park at 1331m, on 24 May. The same situation was seen a day later, 25<sup>th</sup> May 2003, along Battle Creek, Alta., at 1166 m and also as well as at higher elevations near Reesor Lake (1292 m), Alberta. Similar observations may be made each year.

CRATAEGUS ECOLOGY

The Cypress Hills present predominantly a northern short-grass prairie biome broken by large to small patches of forest and shrubby thickets near creek beds along most of the upper part of the northern scarp as well as in some other draws and valleys more generally (Plates 3, 4, 5b). The overall vegetation was discussed by Breitung (1954) and the forests specifically, in some detail, by Newsome and Dix (1988) as well as by Henderson et al. (2000). Each of these papers is notable for a nearly complete lack of attention to hawthorn habitat, in spite of its extent and significance. Forest is concentrated in the middle and upper parts of the north-facing slopes where it can be continuous for miles (Plate 3a). Smaller patches line the deeper ravines.

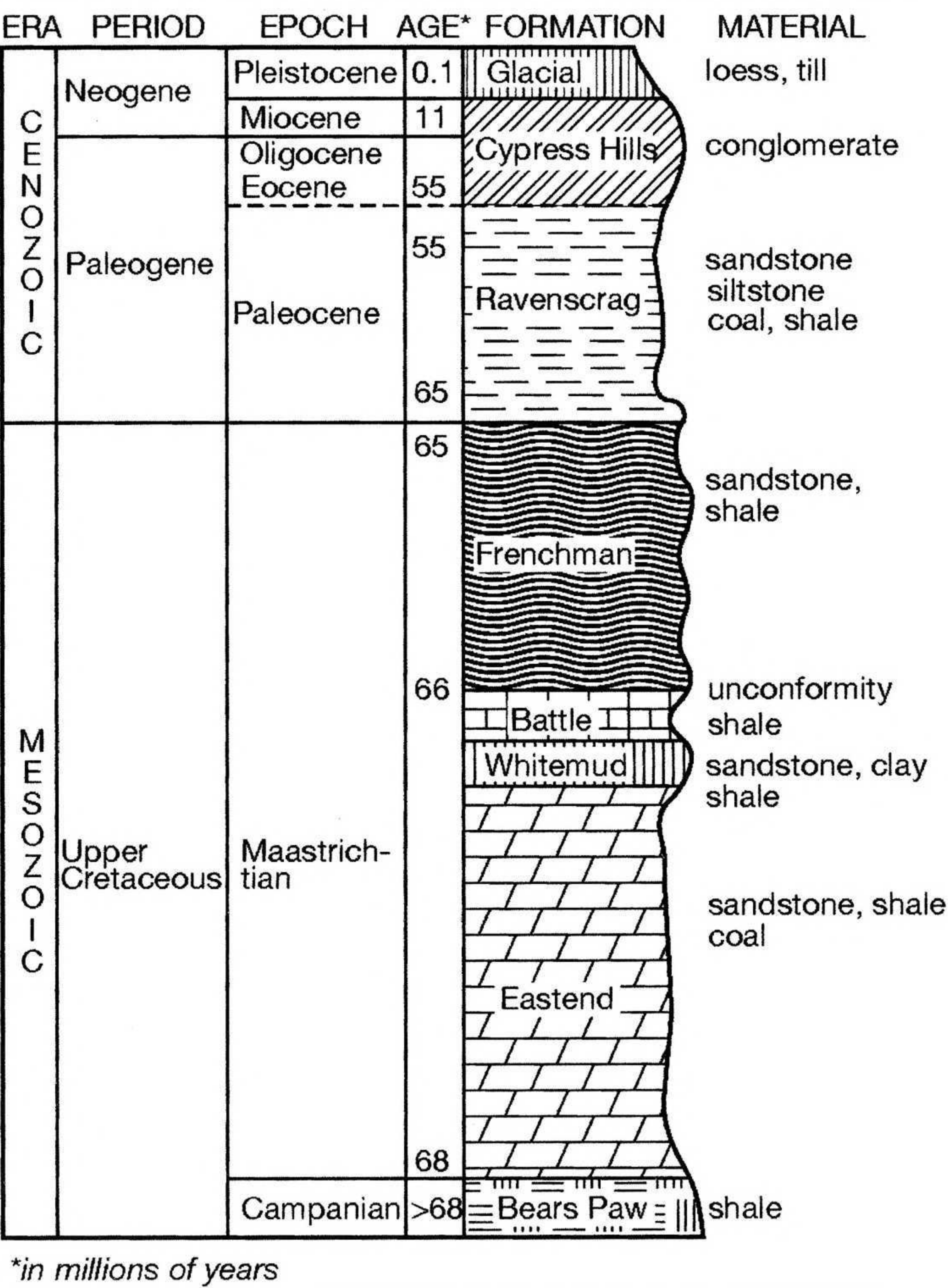


Fig. 3. Geological cross-section of Cypress Hills. Source: Alberta Department of the Environment.



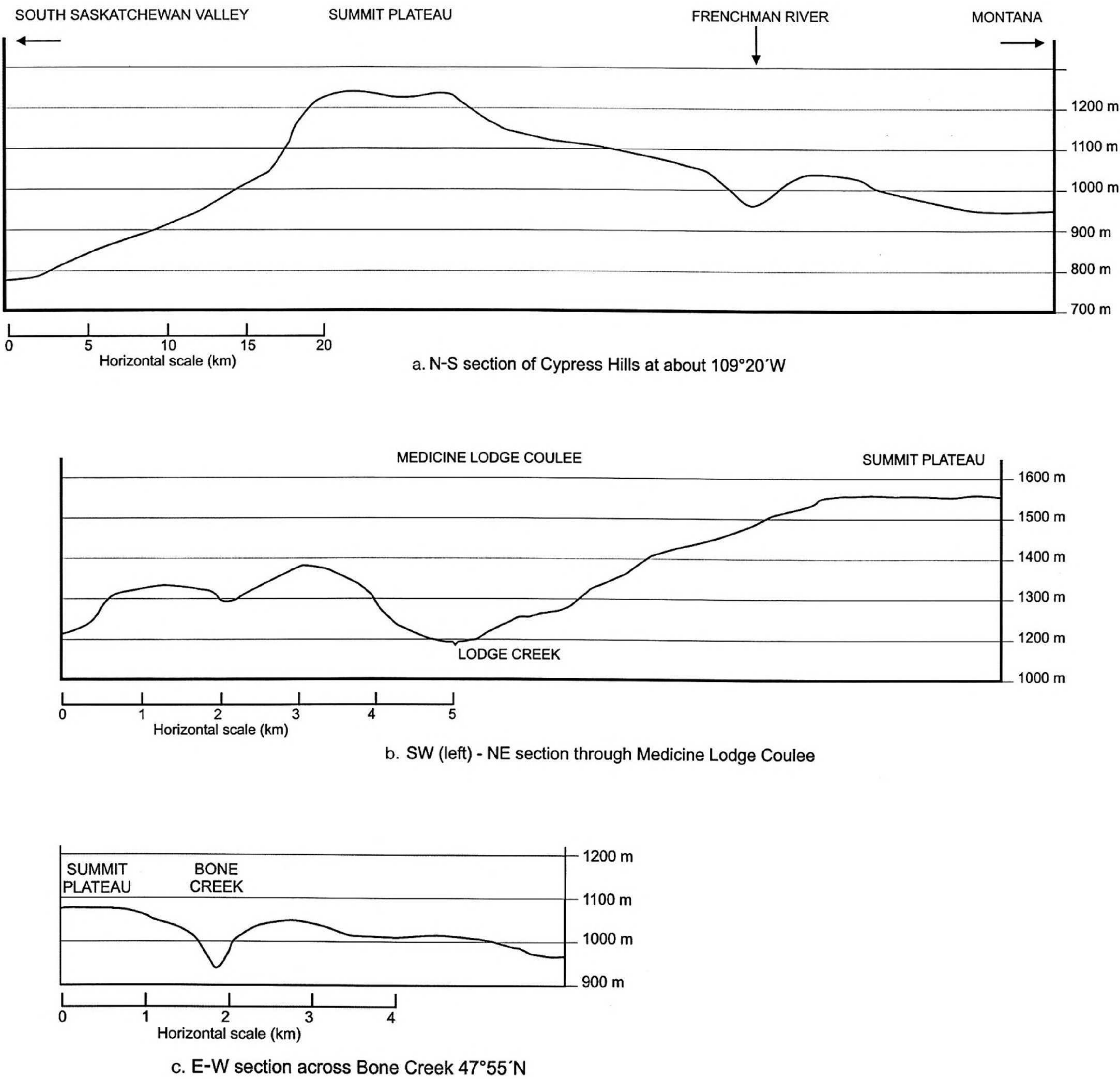


FIG. 4. Topographical cross-sections for three locations in the Cypress Hills, positions shown in Plate 2, p. 1045 a) A–B. North-south section running from just east of Maple Creek. b) C–D. Southwest-northeast section through Medicine Lodge Coulee. c) E–F. East-west section across Bone Creek Coulee.

Aerial surveys indicate that about 5–15% of the Cypress Hills land area is covered by forest or forest-scrub (see map, Plate 2). The trees involved are principally the boreal species white spruce (*Picea glauca*), found in deeper northern valleys and the steeper scarps, the Rocky Mountain species, lodgepole pine (*Pinus contorta*), on drier summit and sub-summit slopes and finally aspen (*Populus tremuloides*) which forms extensive areas of forest or parkland linking many of the white spruce and lodgepole pine stands, primarily on the upper northern slopes and the sides of deeper ravines (Fig. 4c). A few other tree species (e.g., willow, boxelder) occur in small quantity in the deeper valleys. The grassland biome outside of the Inter-provincial Park boundaries is farmed and carries a mix of dryland crops such as wheat and alfalfa as well as fallow (in flatter areas), and rangeland (on slopes).

Hawthorns are found in all parts of the Cypress Hills (Fig. 6a) but reach their greatest abundance as an almost continuous aspen understorey in the more mesic aspen-dominated sites and in thickets, sometimes huge, in north-slope draws and in the deeper coulees. This biome, particularly at higher altitudes and particularly on north and west slopes in the Cypress Hills supports extensive hawthorn thickets along



TABLE 1. Climatic data for Cypress Hills and nearby localities. Mean monthly precipitation (mm) for high elevation northern scarp compared with surrounding prairies.

	J	F	M	A	M	J	J	A	S	O	N	D	Total
Cypress Hills (1196 m)	35.1	28.1	41.9	40.5	76.8	63.8	69.6	47.5	58.2	36.7	35.1	40.7	606.8
Maple Creek (764 m)	25.8	17.1	18.9	30.5	45.7	57.8	45.6	35.4	38.0	18.2	17.9	24.2	375.3
Medicine Hat (717 m)	17.8	10.2	16.4	25.2	42.5	57.5	40.8	29.7	36.8	15.1	15.0	20.0	304.0
Shaunavon 2 (914 m)	18.8	12.8	23.3	24.9	57.2	68.5	52.4	36.4	31.1	18.4	16.9	26.0	384.6
Willow Creek (861 m)	12.4	7.8	16.0	15.6	47.1	60.6	41.3	30.9	32.3	16.3	17.0	16.6	313.8

TABLE 2. Climatic data for Cypress Hills and nearby localities. Mean monthly temperature (°C) for high elevation northern scarp compared with surrounding prairies.

	J	F	M	A	M	J	J	A	S	O	N	D	mean
Cypress Hills (1196 m)	-10.7	-7.8	-3.7	2.8	9.0	13.1	16.3	16.0	9.7	4.3	-3.8	-8.8	3.0
Maple Creek (764 m)	-10.8	-7.0	-1.5	5.8	11.8	16.5	19.7	19.0	12.8	7.4	-2.1	-8.5	5.6
Medicine Hat (717 m)	-10.8	-6.9	-1.2	6.3	12.4	17.0	19.8	19.1	12.9	7.4	-2.1	-8.5	5.5
Shaunavon 2 (914 m)	-11.0	-6.8	-1.9	5.6	11.2	15.5	18.2	17.6	11.7	5.7	-3.9	-9.3	4.4
Willow Creek (861 m)	-11.7	-8.0	-1.5	5.8	11.6	16.2	19.2	18.8	12.3	5.6	-3.8	-9.7	4.6

creeks and in draws (Plate 4a). Such creek thickets represent the bottom part of a catena Morison et al. (1948) where groundwater regimes override topland CMI's and create an interdigitating habitat mosaic this part of which is particularly suitable for hawthorn. Hawthorn numbers are thus concentrated in all those sufficiently mesic sites not dominated by evergreen conifers and CMIs of 10–15 for topland sites may be inferred. The abundance of *Crataegus* under aspen (Plate 4b) in the Cypress Hills represents a new habitat for *Crataegus* so far as the literature is concerned. This kind of situation, relatively mesic and under dappled or light, but not heavy, shade presents an analogue to the rather sparser *Crataegus* understorey below oak and pine that is commonly encountered in the southeastern United States and is to some extent at odds with the relatively often seen observation that *Crataegus* is shade-intolerant. The high negative correlation with fruticose *Salix* species in the Cypress Hills, the latter abundant in some marshy bottomlands may be due to hawthorns' poorer tolerance of periods of waterlogging even though many of these willow habitats apparently dry out extensively during summer. In the Cypress Hills hawthorns are virtually never found in the open prairie away from draws and similarly mesic sites and their distribution there is in line with the general interpretation of most North American hawthorn species being mesophytes rather than being particularly xeromorphic.

Possibly also a significant factor in the regionally extraordinary abundance of hawthorn in the Cypress Hills is the absence of *Juniperus*, alternate host of the damaging *Gymosporangium* rust. Injury by this rust is infrequent in the Cypress Hills and to cause infection *Gymosporangium* would need to migrate into the area annually.

ORIGINS OF THE CYPRESS HILLS WOODY FLORA

The origins of woodland in the Great Plains generally and the Cypress Hills particularly are topics of direct relevance to this paper. Sauchyn and Sauchyn (1991) in an account of the Holocene pollen record of Harris Lake in the Cypress Hills and Porter, Sauchyn and Delorme (1999) in a parallel account of the ostracod record of the same lake inferred vegetation change for the Cypress Hills and set it in a wider context. Harris Lake, elev. 1180 m (Plate 5b), is about 9 ha. in size and lies about 5 km northwest of Adams Lake (mapped, Fig. 1b) just below the steepest part of the northern scarp of the Cypress Hills. Today, Harris Lake has *Picea glauca* and *Pinus contorta* forest upslope, some aspen around the lake and grassland downslope towards the north and northeast. It is known to have been in a meltwater channel that existed about 12,000 B.P. during



the main deglaciation. However, continuous pollen and ostracod records only exist from ca. 9,200 B.P. so the above authors assume that it was in the missing interval ca. 12,000–9,000 B.P. that the main invasion of *Picea glauca*, a species whose abundance later fluctuated greatly, occurred.

Inferences of vegetation from the two papers cited above are slightly different so the more recent paper is used here. Four main paleoenvironments are recognized for the Cypress Hills, I–IV. Zone I, early Holocene, 9240–6400 B.P., had a variable climate supporting aspen parkland; Zone II, Hypsithermal, 6400–4500 B.P., was warm and dry supporting grassland and only small patches of forest; Zone III, moister and cooler, 4500–3600 B.P., had expanding subboreal forest; while Zone IV, 3600 B.P. to the present, represents short grass prairie with islands of trees. An important deduction in the earlier paper is that *Picea glauca* probably persisted in small patches through the Hypsithermal. This implies continuity for *Picea glauca*, the most mesophytic of the three main tree species, at least at low abundances, continuously since its main invasion. It is also notable, however, that when a microscope is applied to the time periods, quite sharp climatic changes have been shown to occur in the region even during the approximately 120 years for which meteorological records were available for this area (Sauchyn & Beaudoin 1998), although the extent to which this impact overall survival of quite long-lived woody species is less clear.

Interpretation of the *Crataegus* record for the Holocene for the Cypress Hills remains inferential, however, as it is insect-pollinated and no pollen evidence has been found, while macrofossils, also generally rare for *Crataegus*, have not turned up either. What we have independently established, however, is that Cypress Hills *Crataegus* occur abundantly in mesic aspen woodland (CMI of ca. 10–15) as well as along numerous creek beds of appropriate, and probably averaging similar, mesicity. It is therefore probably safe to infer that the Cypress Hills, since the time *Picea glauca* was first present, i.e., ca. 11,000 to 10,000 B.P., have continuously contained at least some habitat sufficiently mesic for *Crataegus* but that this habitat has probably fluctuated greatly in extent in the intervening period. The first suggestion of extensive areas of suitable habitat is therefore coterminous with Zone I, aspen parkland, 9200–6500 B.P. Nevertheless, Zone I was not necessarily the first Cypress Hills paleoenvironment to support *Crataegus* as that would have depended on the presence of similarly suitable source paleoenvironments to the south and southwest, especially in the Bears' Paw Mountains and the Sweet Grass Hills about which parallel information is not available. However, three or four Cypress Hills species seem to have some ability to survive along watercourses in the open prairie (and thus are not restricted to montane areas). These species are *Cc. chrysocarpa*, *sheridana*, *sheila-hippsiae* and perhaps *rubribracteolata*. Each of the Bears Paw Mountains and the Sweet Grass Hills are much smaller in area than the Cypress Hills, nevertheless the former so far has nine species of hawthorn recorded while the smaller Sweet Grass Hills, only three so far found, in spite of hosting seven conifers compared to two for the Cypress Hills. From such types of consideration, one can deduce that the quantity of suitable receiving habitat, together with its continuity, nearness to source populations, the time available for colonization, as well as later unfavorable climatic bottlenecks are all relevant to the size, persistence and diversity of immigrating populations. Nearness to source populations needs to be further interpreted with respect to dispersal ability of different *Crataegus* species about which almost nothing is yet known in a precise way. Solutions to the problem of origin will thus be helped by greatly increased knowledge of dispersal ability and detailed habitat preferences among the different species and also by reliable inferences on the age of different *Crataegus* taxa involved in addition to the other factors mentioned. Therefore, the present nearly comprehensive lack of such hard information prevents for the time being obtaining firm answers about the origin of the Cypress Hills *Crataegus* flora so, instead one has to resort to inferences derived from general habitat preferences, relative abundance of same and current biogeography.

#### TAXONOMIC PART

##### Introduction

Thirteen species of *Crataegus* occur in the Cypress Hills: *C. douglasii* Lindl., *C. castlegarensis* J. B. Phipps and Kennon, *C. chrysocarpa* Ashe, *C. sheila-hippsiae* J.B. Phipps & O'Kennon, *C. macracantha* Lodd. ex Loudon, *C. sheridana* A. Nels. plus the seven new species described below. Previous authors (Boivin 1967; Moss



1959; Packer 1983; Scoggan 1978) had listed two—*C. douglasii* and *C. chrysocarpa* (sometimes listed as *C. rotundifolia* Moench) or three (Breitung 1954), adding what he called '*C. columbiana*' the only cited specimen of which that we have located proving to be *C. aquacervensis*, so our paper constitutes a major development in the understanding of this flora.

The arrangement of species in this paper is according to small, rather narrowly defined phenetic groups treated as series. However, one of the newly described species (*C. rubribracteolata*), and the long-overlooked species (*C. sheridana*) considerably widen the concept of an existing series, in this case *Macracanthae*. In view of the evolving understanding of correct sequence of bifurcations in the *Crataegus* evolutionary tree from molecular work, a vague assignation like this seems entirely acceptable for the present. Even so, two new series '*Cupressocollinae*' and '*Montaninsulae*' are designated to handle other species that do not fit serial circumscriptions as currently understood.

Characters used in the descriptions are the numerous, over 50, morphological characters mainly standard in careful *Crataegus* species descriptions. A recent addition to these characters is the case of bracteoles which have now been systematically recorded by the first author in descriptions of Chinese (originally planned for Flora of China) and North American (to appear in FNA) taxa. More meticulous study (Dvorsky & Phipps 2005a, 2005b) now allow it to be stated that nearly all bracteoles observed in Cypress Hills *Crataegus* belong to Dvorsky's types 1a and 1b (revised numbering follows thesis and forthcoming papers) which characterize the majority of Asiatic and North American species. Bracteole type 1 refers to the symmetric type found in all *Crataegus* species and is usually small, caducous, membranous, narrow or linear and slightly venous. Subtypes 1a and 1b are characterized by the presence of sessile or short-stipitate glands around the margins, in which the color when young for *C. rubribracteolata* (Plate 8a) is a solid clear red-brown (hence the name) although this often fades with age. Only a few *Crataegus* species have intensely colored bracteoles, the most striking being *C. phippsii*, also western Canadian and adjacent United States, in which they are crimson. *Crataegus cupressocollina* bracteoles, however, are closer to subtype 1c as they nearly completely lack marginal glands (Plate 6.1c).

Nineteen of the more useful of the characters used in the descriptions and the keys are presented in Table 3 to summarize the manner in which they vary between species. A number of these are continuous characters about which it is difficult to be more than very general in a table. For instance, leaf length in Cypress Hills *Crataegus* ranges from 'small', 3–4 mm long, to 'large', ca. 6–8 mm long. However, such characters may be still excellent discriminators, at least among species with dissimilar values. As there is nearly always fairly significant variation in leaf size on a given specimen the terms are limited to a central tendency, rather than including the extremes. Such central tendencies become more useful discriminators. Numerical equivalents are provided for the central tendencies in the caption to Table 3 while subjective terms are used for shorthand purposes in the table. An exception involves density of indumentum which is too complicated to assess numerically with any ease and, even if it were done, would provide significant difficulty for the user.

Eight of the continuous variables appearing in Table 3 were those of particular value in separating certain species. These were sampled over a substantial range of individuals if such was available in order to calculate their ranges, means and standard deviations. These results are presented as box plots in Figures 5a to 5c and are discussed at relevant points in the text.

We also try to give some measure of precision to the degree of leaf incision, the 'leaf incision' index or 'LII' ('IFI' in Latin), which represents the percentage of width of the lamina diminished by a sinus as measured by the line from the midrib to that sinus parallel to the veins to the adjacent lobes and compared to the same line projected through the sinus to the intersect of the adjacent lobes. This may vary from 0% (no lobing) to 100% (blade cut to midvein).

## Identification

In identifying Cypress Hills *Crataegus*, whether in the field or herbarium, most of the characters used in the descriptions may be valuable but additional characters, hard to specify precisely, often of stature, branching pattern, foliage color and reflectivity, planeness and size of leaves at anthesis, precise anthesis order,



TABLE 3. Morphological characteristics of value in identifying Cypress Hills hawthorns.

	<i>cupressocollina</i>	<i>douglasii</i>	<i>castlegarensis</i>	<i>aquacervensis</i>	<i>rivulodadensis</i>	<i>purpurella</i>	<i>rivulopugnensis</i>	<i>macracantha</i>	<i>rubibracteolata</i>	<i>sheridana</i>	<i>ursopedensis</i>	<i>shelia-hippsiae</i> <i>v. saskatchewan</i>	<i>chrysocarpa</i>	<i>"Brett Gaff"</i>
leaf size	M	S	S	M	M	S	S-M	M	S-M	SM	M-L	S	S	M
lobe size (Lil)	max.	us.	us.	max.	Us.	max.	max.	CH	max.	max.	max.	max.	us.	3
lobe no./side	15-20	10-15?	10-15	15-25	5-20	15-25	15-25		25-33	10-20	25-35	15-30	15-25	
lobe sharpness	3-4	0-2	0-3(-4)	3-4	2-4	2-3	3-4	3-5	5-6	4	4-5	2-3	2-3	4
petiolar glands	4-5	1-3(-5)	2-3	4?	ca. 3	2-3	2-3	2	3-5	3	4-5	4-5	2-4	
petiolar glands	f	f	o	sev.	o-f	o-f	o-sev.	o	f-M	sev.-M	f-M	sev.	sev.	sev.
thorn length	M	S	S	M	S	S	S-M	M	M-L	S-M	M-l	S-M	S-M	M
1yr old wood	r-br.	br.-d.	br.	v.dk.	v.dk.	v.dk.	v.dk.	v.dk.	mid. br.	d.r.br.	r-br.	d.r.br.	mid. br.	r.-br.
fls/infl. (median)	10	10-25	8-20	8.5	7	10	10	10-15	8	10	8	6	7	7
ped. pubescence	2-3	0	2-3	2-4	4-5	2-3	2-4	5	5	5	4-5	1,0	3	5
bract. freq.;	5	3	3	3	3	3	1-2	3-4	5	3	3-4	3	3-4	4/-
bract., type	1a/1c	1a	1a	1a	1a	1a	1a	1a	1a	1a	1b	1a	1a	
fl. diam. (mm)	15-18	12-15	12-15	15-18	17-21	13-16	16	17-21	12-15	15	16.5	18	14-16	16-18
stamen no.	10	10	10	10	10	10	10	10	10	10	10	20	10	10
anther color	w	pk	pk	pk	pk	pk	pk	pk*	w	w	w	w	w	w
fruit color, early	burg	bl	pur.	plum red	dk red	burg	red	red+	red	red	or-red	or-red	red+	red
fruit color, late	±bl	bl	pur-bl	pur	bur-pur	pur	red	red	br. red	br. red	red	red	red	deep red
fruit pubescence	0	0	1-3	1-3	3-5	0	0	4-5	3-5	4-5	0-4	0	us.0(5)	3
calyx-lobes, fruit	L	sh	sh	sh	M, rec	M, pat	M, pat-rec	±appr.	appr-sh	pat-refl.	pat.-appr.	refl.	pat.	pat.
nutlet no.	3-5	3-4	3-4	3-4(-5)	3-5	3-4	3-5	2-3	3-4	3-4	3-4	3-4	3-4	3
lateral erosion	y	y	y	y	-	-	-	y	y	y	-	-	-	-

+ orange west of Rocky Mts.      \* normally white west of Rocky Mts

abbreviations:

appr = appressed

burg = burgundy

M = medium

pur = purple

sh = short

o = occasional

r = red

us = usually

bl = black

dk.= dark

or = orange

rec = recurved

v = very

br = bright

f = frequent

pat.= patent

S = small

w = white

bract = bracteole

L = long

pk = pink

sev. = several

y = yes

Explanation of values:

thorn length: S= 15-30 mm, M= 25-40 mm, L = 40+ mm.

leaf length, mature, central range: S= 35-45 mm, M= 40-60 mm, L= 55-75mm.

lobe sharpness: 1=blunt, 5=acuminate. lobe depth: max. Lll in %.

petiole gland frequency, mean: o= 0-1, sev. = 2-3, f= 4+.

pubescence: 0 (glabrous) to 5 (very dense).



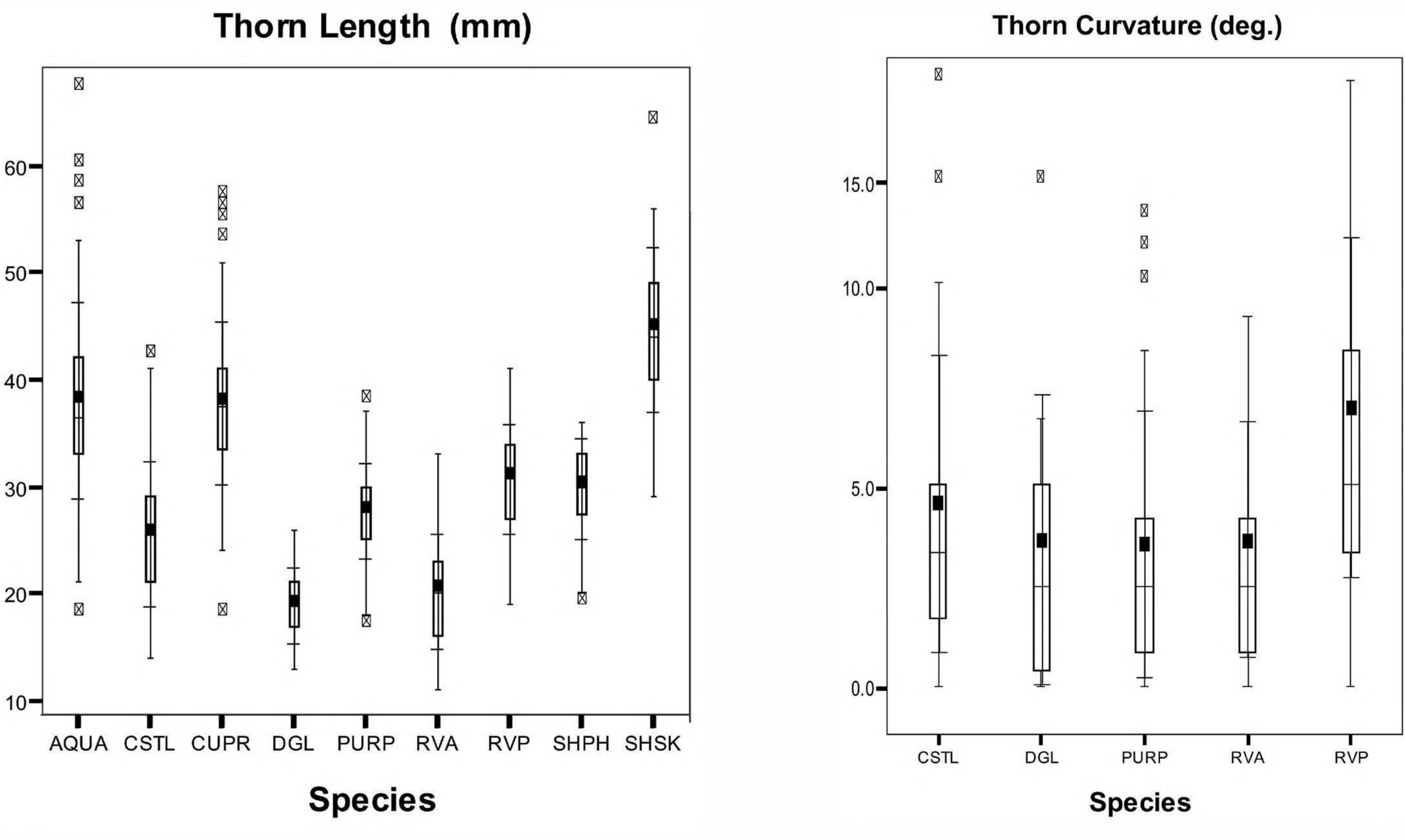


FIG. 5a. Box plots of selected characters showing means (black squares), standard deviations (inner pair horizontal ticks), medians (central tick in box; may be hidden by mean), central 50 percentile (box), ranges (outer pair horizontal ticks), isolated records per SPSS 15.0 (small glyphs beyond range limits). (left) Thorn length (mm). (right) Thorn curvature (deg.). Acronyms for taxa are: AQUA = *C. aquacervensis*, CUPR = *C. cupressocollina*, CHRYS = *C. chrysocarpa*, CSTL = *C. castlegarensis*, DGL = *C. douglasii*, PURP = *C. purpurella*, RBR = *C. rubribracteolata*, RVA = *C. rivuloadamensis*, RVP = *C. rivulopugensis*, SHER = *C. sheridana*, SHPH = *C. sheila-hippsiae* var. *sheila-hippsiae*, SHSK = *C. sheila-hippsiae* var. *saskatchewanensis*, URSO = *C. ursopedensis*.

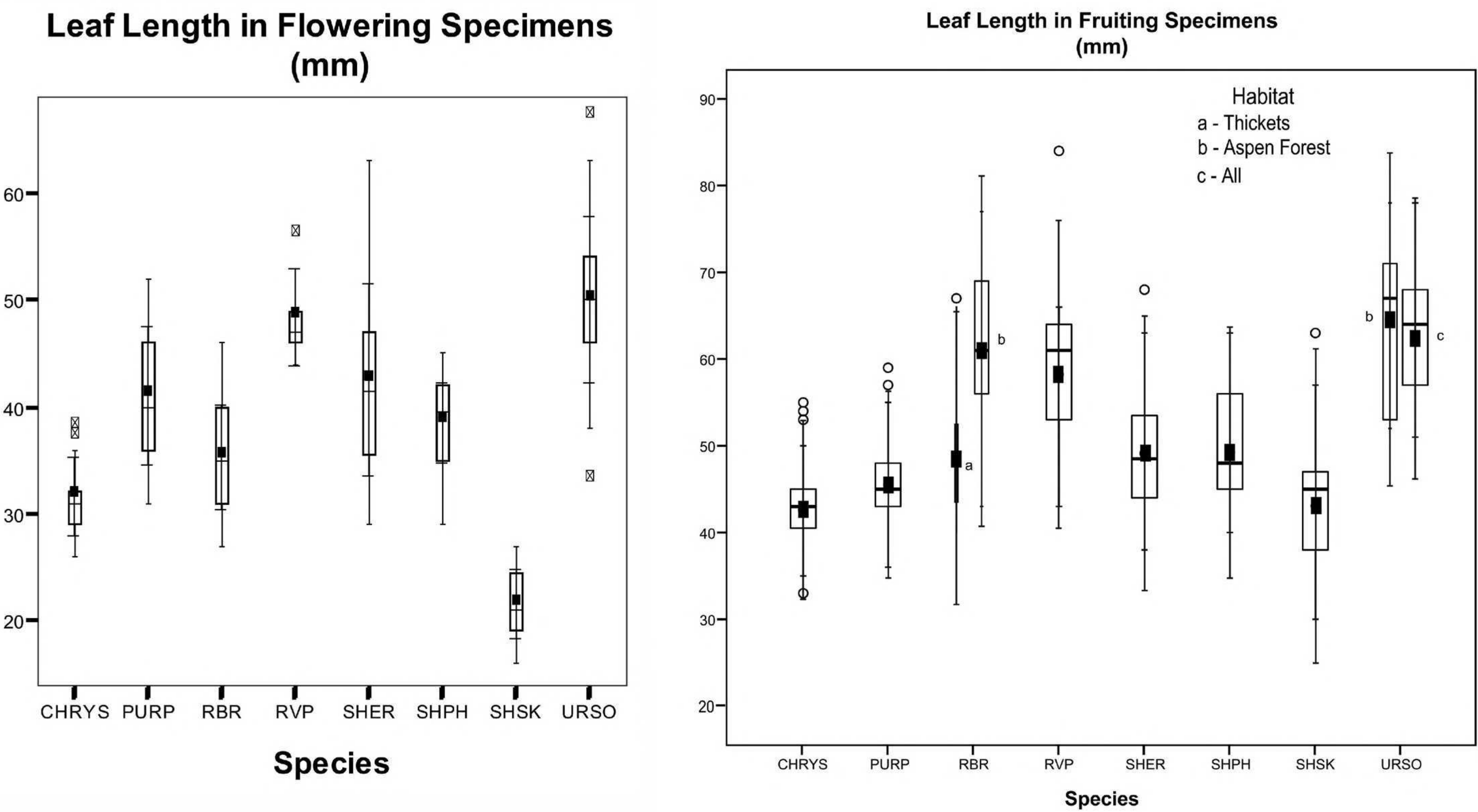


FIG. 5b (box plots continued). (left) Leaf length, flowering specimens (mm). In the case of the two varieties of *C. sheila-hippsiae* measurements are restricted to those inflorescences who about 50% of flowers in still in popcorn' (late bud). (right) Leaf length, fruiting specimens. See Fig. 5a for acronyms of taxa.



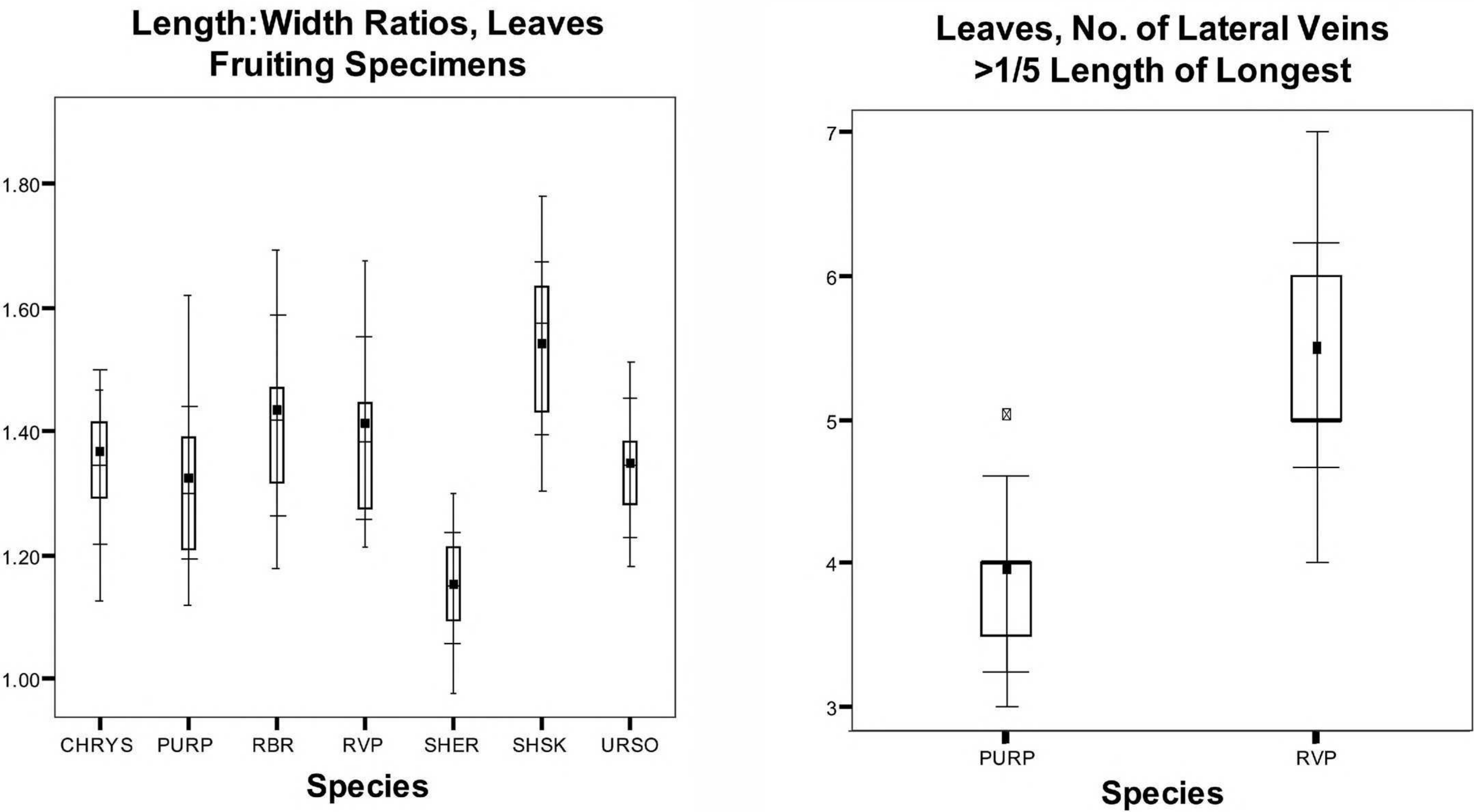


FIG. 5c (box plots continued). (left) Leaf ratios: length/width. (right) Leaves, number of lateral veins more than 10% length longest. See Fig. 5a for acronyms of taxa.

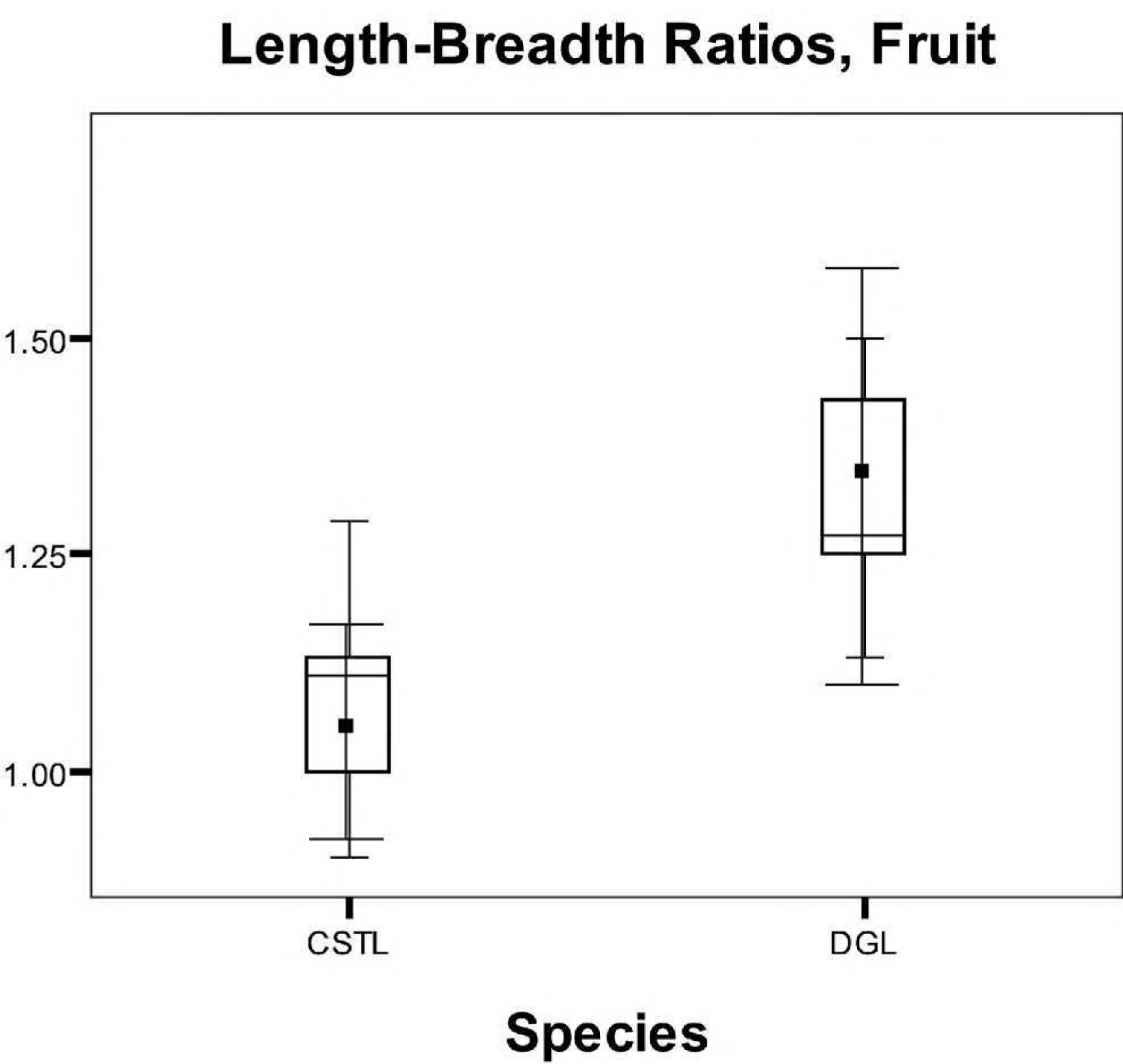


FIG. 5d (box plots continued). Fruit ratios: length/width. See Fig. 5a for acronyms of taxa.

etc. frequently permit recognition from a distance before key characters can be individually observed. This is often referred to as the ‘facies’ of a plant and its recognition comes with practice. Nevertheless, the facies has the potential to reinforce a species concept based on technical characters. Leaf shape and size are somewhat variable within species but are nonetheless important field characters. However, while extension shoot leaves are quite often in some species close to typical shape and size their considerable potential for plasticity suggests great caution in their use. Nearly all short shoot leaves found in the Cypress Hills belong to the principal leaf-shape group in North American *Crataegus* (more or less shallowly lobed, no veins to sinuses) but even so there may be significant specificity of detail. By far the most abundant form of *Crataegus chrysocarpa* for instance, should be quite easily recognizable from sterile material. And in the case of *C. ursopedensis*, the stimulus for the original search for came from a single sterile specimen with huge leaves noticed in herbarium of the University of Montana at Havre at a time when the remainder of its characteristics were quite unknown. It is, nevertheless, quite difficult to describe the exact form of leaves with the precision required for discrimination, especially taking into account some variation, and in this context the illustrations are intended to help. Also note that at anthesis leaves are still in a state of expansion and may be much smaller than at maturity. Anther color is important but anthers may be blackened by frost during morphogenesis and in any case usually become brownish by late flower. Nearly all Cypress Hills *Crataegus* taxa possess a mode of 10 stamens and only one, *C. sheila-hippsiae*, 20. ‘Ten’ and ‘twenty’, seemingly precise values, may





**PLATE 1.** Topographical map of part of north-central Montana, southern Alberta and Saskatchewan showing location of the Cypress Hills. Topographical coloring: green—below 500 m; yellow-green—500-1000 m; pale brown—1000-2000 m; darker tones of brown each extra 1000 m. Relief also highlighted by shading. Scale: 100 km = 31 mm.

be taken as approximate, morphogenetic control being more or less imprecise in this matter. For instance, both stamens and style numbers may be radically reduced by low temperature damage during early flower development. Fruit color at full ripeness is basically either in the purple to black range or red. However, earlier, the purple to black fruit type may be plum-red or similar, while over mature red-type fruit may be a similar deep red. Also, some red-type fruit may be orange-red young. Therefore, with changing fruit color, comparison must be made at comparable points in the season. Pubescence of the inflorescence branches may be partially lost through the summer, generally leading to more variable indumentum in infructescence than inflorescence branches. The lateral face of the nutlet is another important characteristic to use in identifying *Crataegus* but it is easy to go wrong with this if the sides are not properly cleaned. Scraping the flesh carefully off the sides of typical (but not very narrow nor deformed) nutlets does not automatically reveal the pitting as this can remain full of flesh. So a fine probe must be used to see if excavation is possible. Species such as *C. chrysocarpa* and *C. sheila-phippisiae* have plane to slightly convex (plump) or very shallowly concave sides, while others such as *C. macracantha* and *C. douglasii* have pitted or ‘eroded’ sides, the erosion of which may be quite irregular. The typical states for these characters are shown for each of



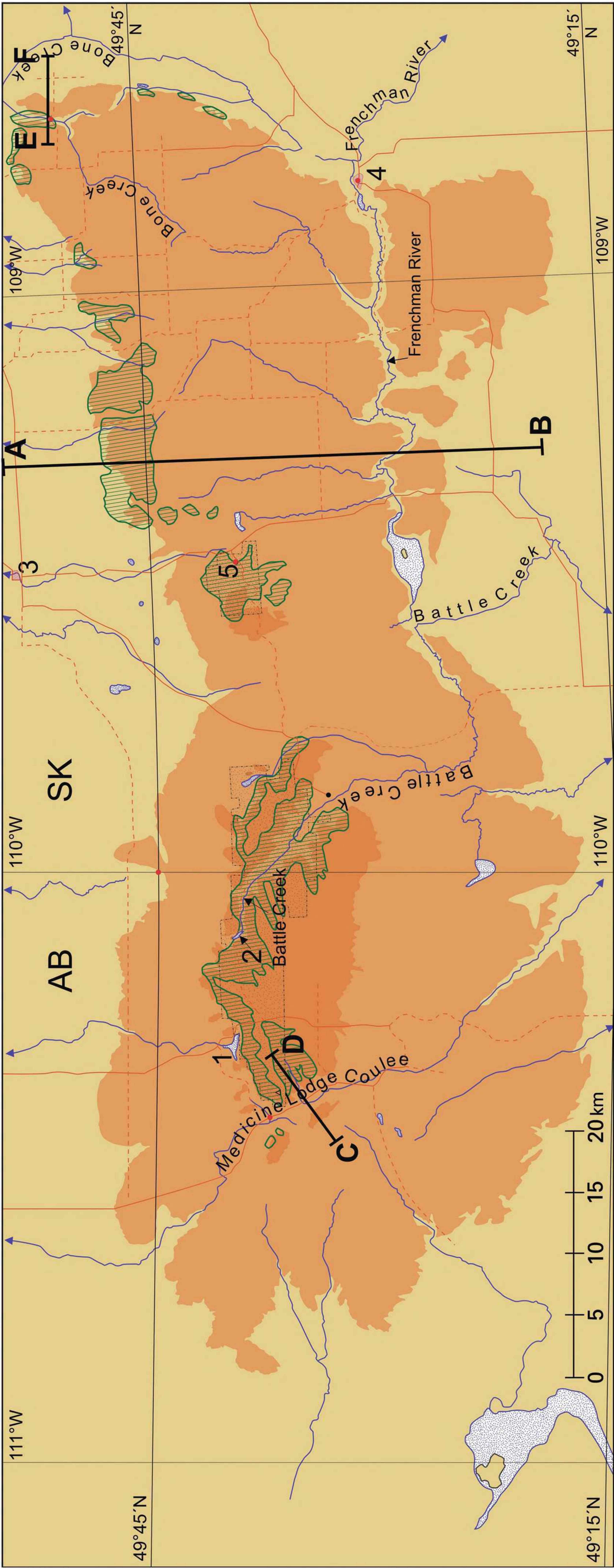


PLATE 2. Cypress Hills topographical map with overlay (in green) indicating distribution of larger patches of woodland. The five locator points for comparing with range maps are: 1 = Elkwater, causeway on AB 41; 2 = northern tip, Reesor Lake, AB; 3 = Maple Creek, j ct. SK 21/271; 4 = East end, SK; 5 = Cypress Hills Provincial Park HQ, SK. Brown tonal changes are at the 1000 m and 1250 m contours. Lines A-B, C-D and E-F are positions of sections (see Fig. 4).



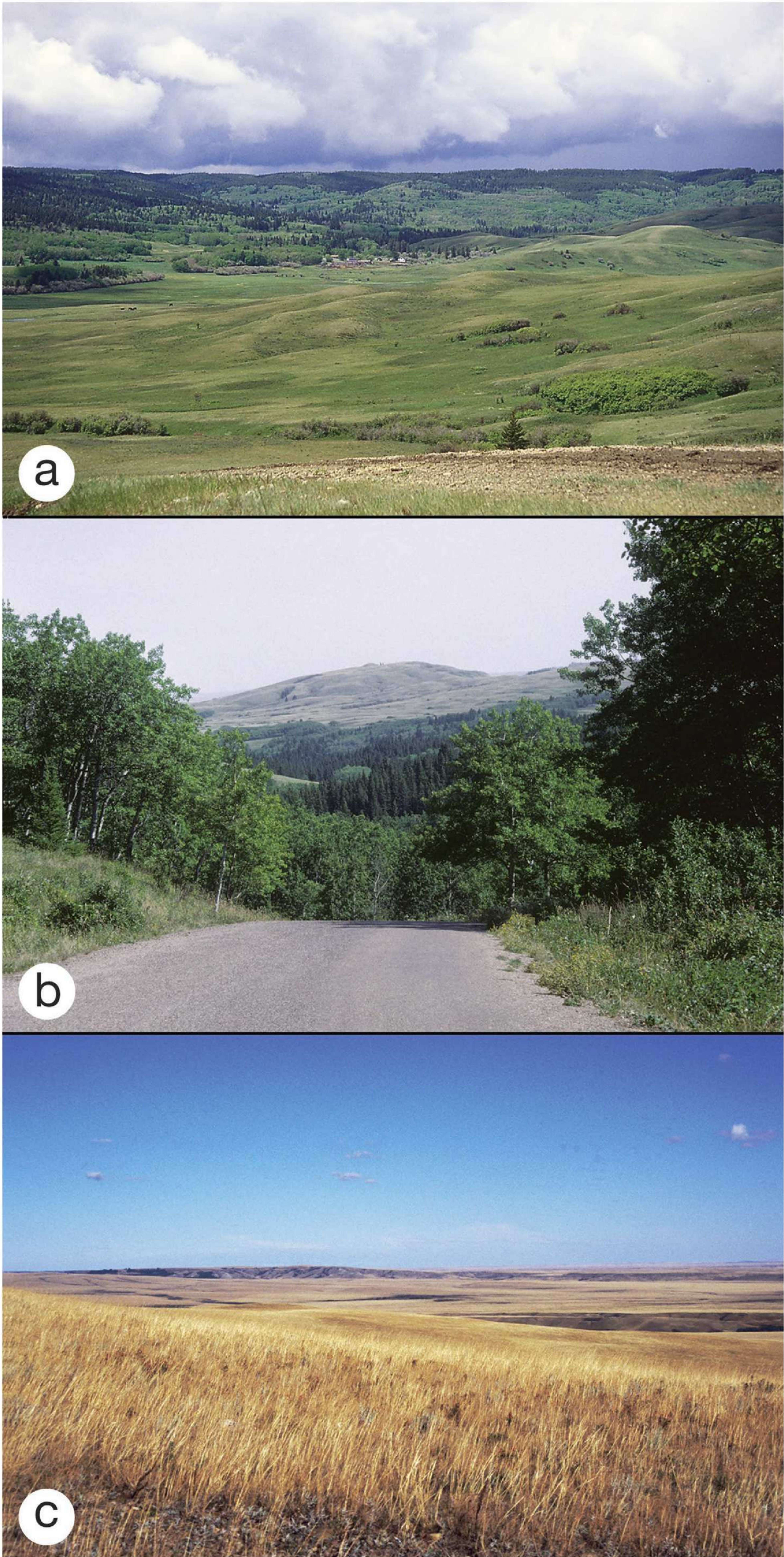


PLATE 3. Cypress Hills habitats 1: a) Udal Ranch on upper Adams Creek, SK with valley floor at ca. 1240 m showing forested slopes with *Picea glauca* (dark) and aspen woodland (pale), also some short-grass prairie with *Crataegus* thicket along draw. b) View down Spruce Coulee Rd. near Elkwater, AB looking out to dissected top of northern scarp; foreground at abt 1200 m; *Picea glauca* woodland, aspen and upper level grassland all visible; *Crataegus* is abundant in foreground aspen. c) Prairie grassland with CMLs below -30 stretching into Montana from upper southern slopes (foreground at 1275 m), SK.



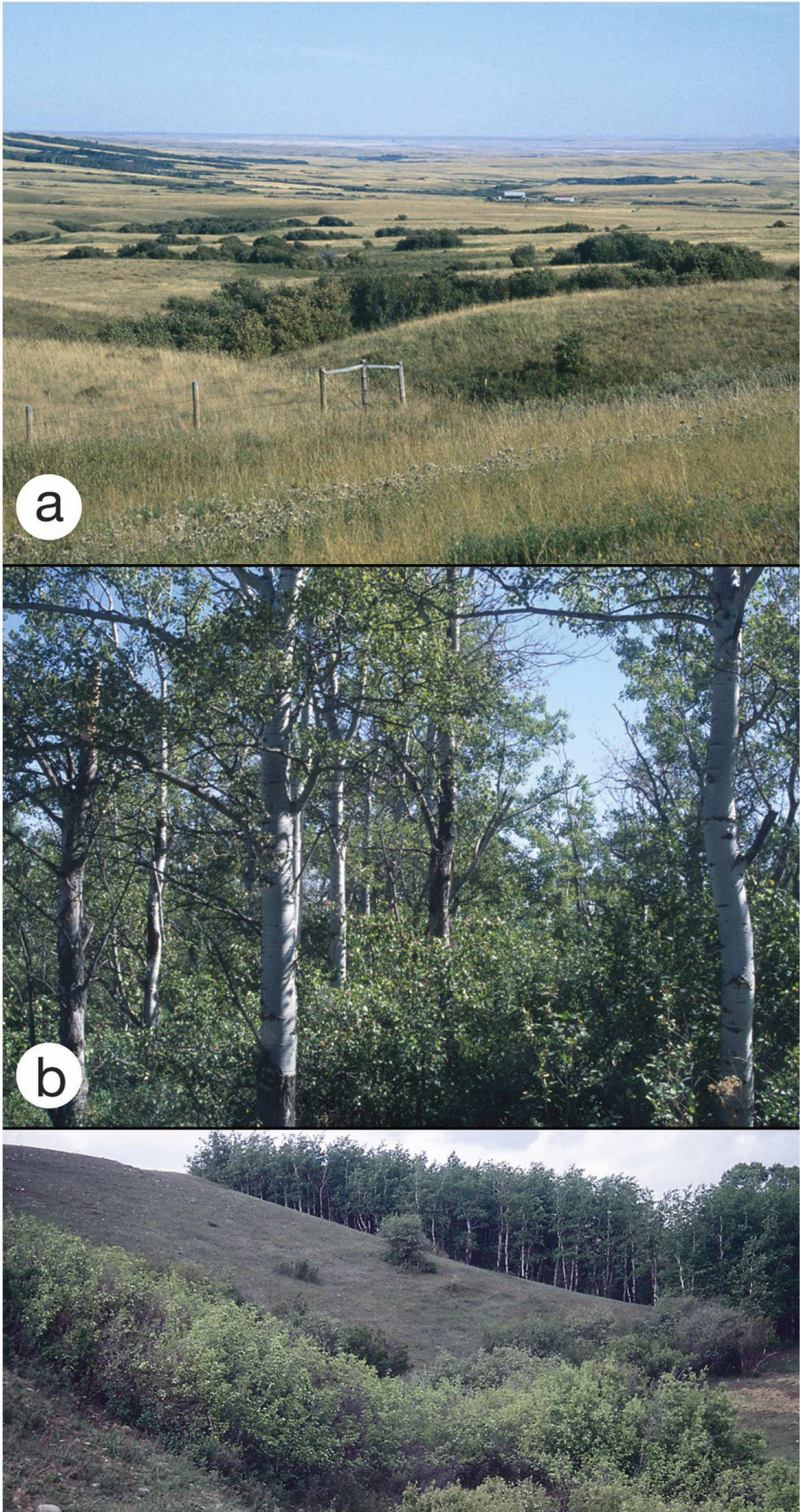


PLATE 4. Cypress Hills habitats 2: a) View north from headwater region of Maple Creek, SK showing extensive hawthorn thickets with some aspen (larger plants); foreground about 1000 m. b) Interior of aspen forest with dense *Crataegus* understory at about 1250 m on Udal Ranch near headwaters of Adams Creek. c) Fairwell Creek Coulee with valley bottom at about 1070 m showing seepage zone thicket mainly of *Crataegus ursopedensis* (left foreground), grassland, and aspen woodland (background).





PLATE 5. Various: a) Snow in summer, Sep 17 2003, *Crataegus rubribacteolata* and author (JBP); small draw west of SK 21, elev. 1100 m. This picture exemplifies the unpredictable nature of Cypress Hills weather towards the end of the growing season. Similarly heavy snow has also been experienced by the authors in May of 2004 at full anthesis of many *Crataegus* species. b) Harris Lake, SK, the source of data for the reconstruction of the Cypress Hills Holocene vegetation record; view approximately SW at 1180 m elev., Sep 2004; Harris Lake is ca. 10 km NW of Adams Lake shown on Fig. 2. c) Author (RO'K) and *Crataegus rivulopugnesis* (JBP & RO'K 8533) at its first encounter, above Shafer Creek, SK, 13 Sep 2003, elev. 1258 m.



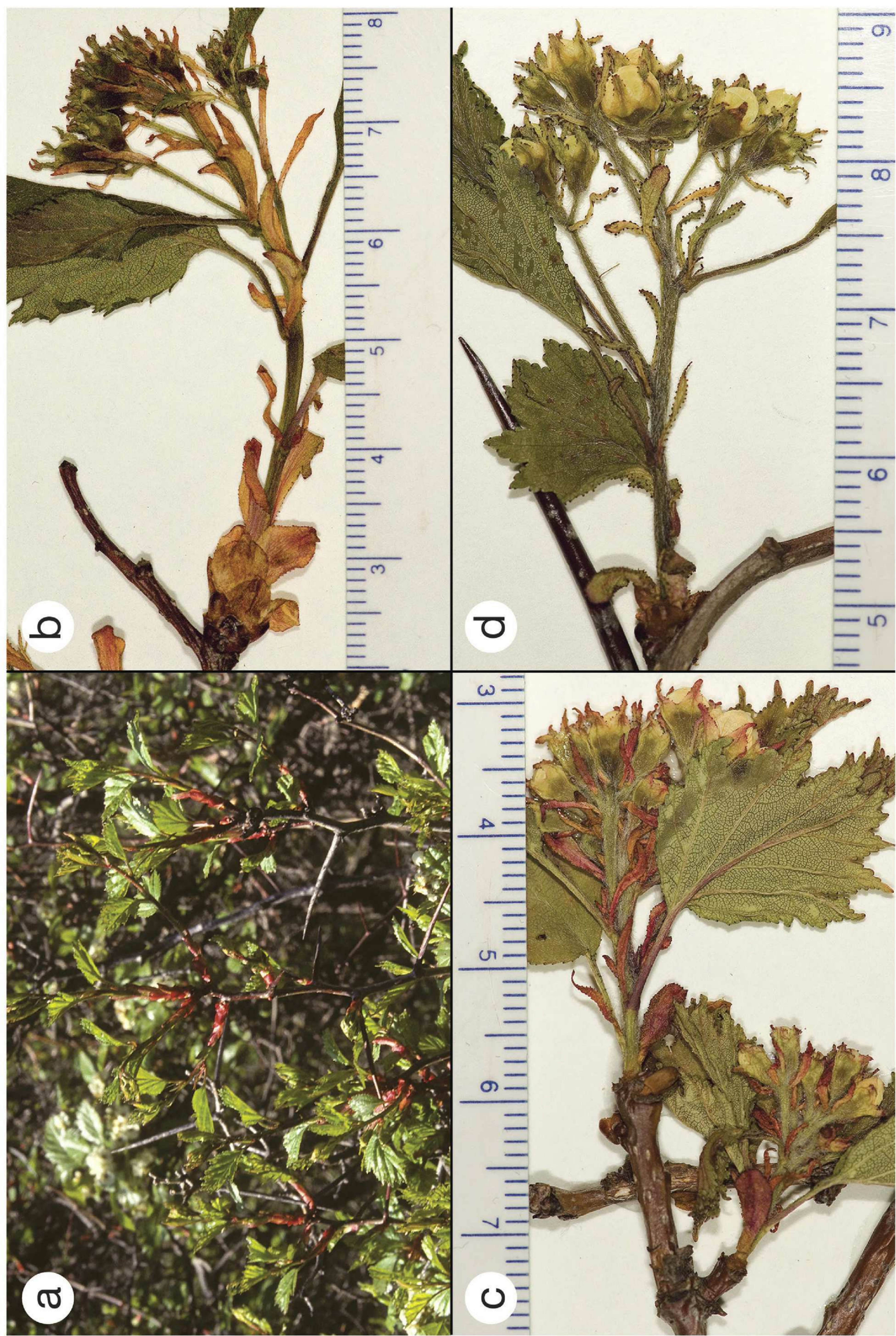


PLATE 6.1. Illustration of some bracteoles and budscales: a) *Crataegus macracantha* showing characteristic highly colored budscales, in background are flowers of the much earlier flowering *C. rubribracteolata*. b) *Crataegus cupressocollina* (JBP & O’K 8469) illustrating inconspicuous and relatively few marginal glands. c) *Crataegus rubribracteolata* (JBP & O’K 8673) showing solid rust-red coloring of bracteoles and smallish marginal glands. d) *Crataegus ursopedensis* (JBP & O’K 8968) showing larger and much paler bracteoles with much more prominent marginal glands.



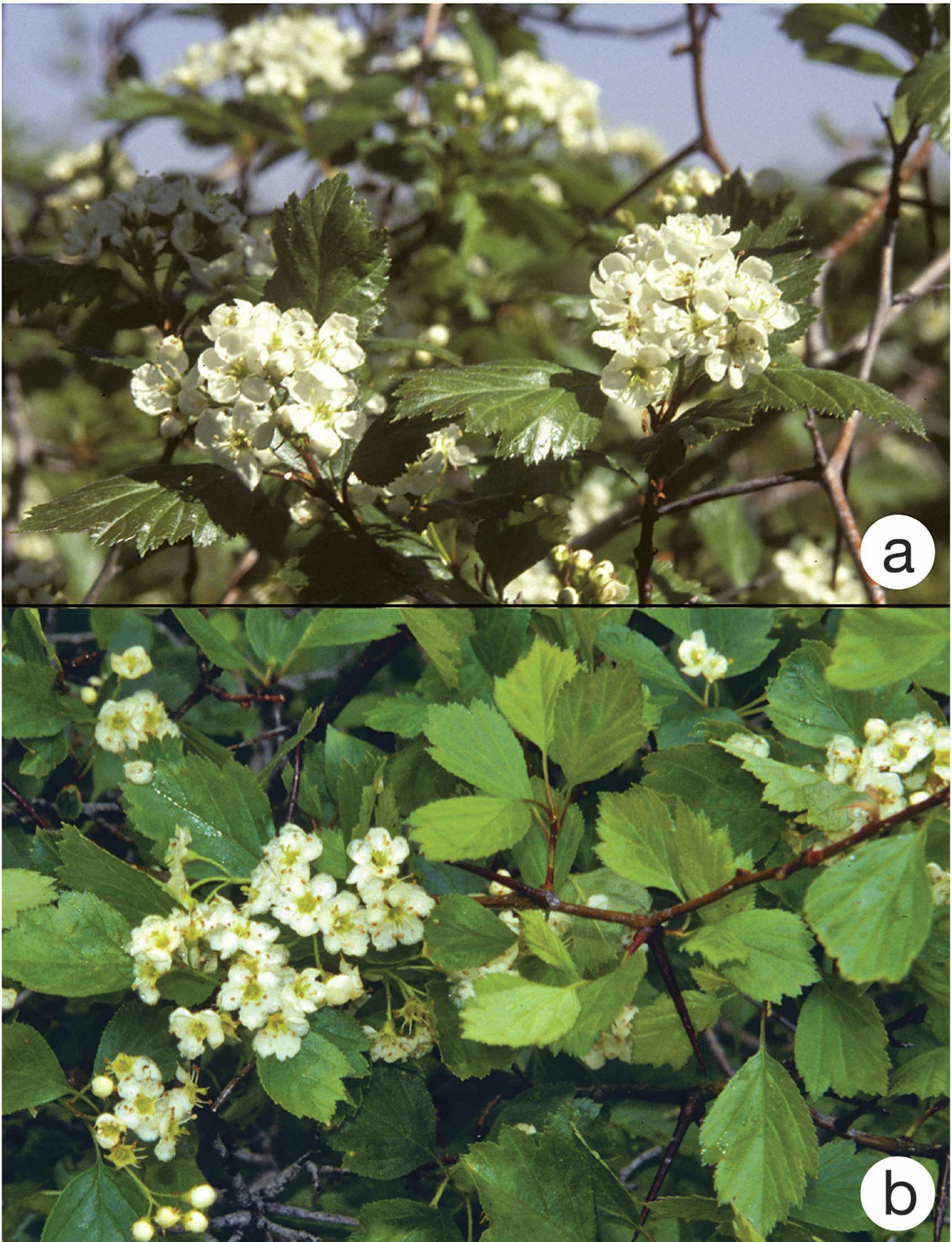


PLATE 6.2. Portraits of flowering specimens of selected species of Cypress Hills *Crataegus*: a) *C. cupressocollina* (JBP & O'K 8508), near Eastend, SK. b) *C. purpurella* (JBP & O'K 8984), near Loch Lomond, CHPP, SK.





PLATE 7.1. Portraits of fruiting specimens of Cypress Hills *Crataegus*: a) *C. cupressocollina* (JBP 9156) at the rarely observed reddish stage; SK 271 above Adams Creek. b) *C. cupressocollina* (uncollected specimen at mid-ripe stage, later becomes glossy purple-black); location close to last. c) *C. castlegarensis* (JBP 9240), West Butte, Sweet Grass Hills, MT. d) *C. castlegarensis* (JBP & O’K 8792), Elkwater, AB.



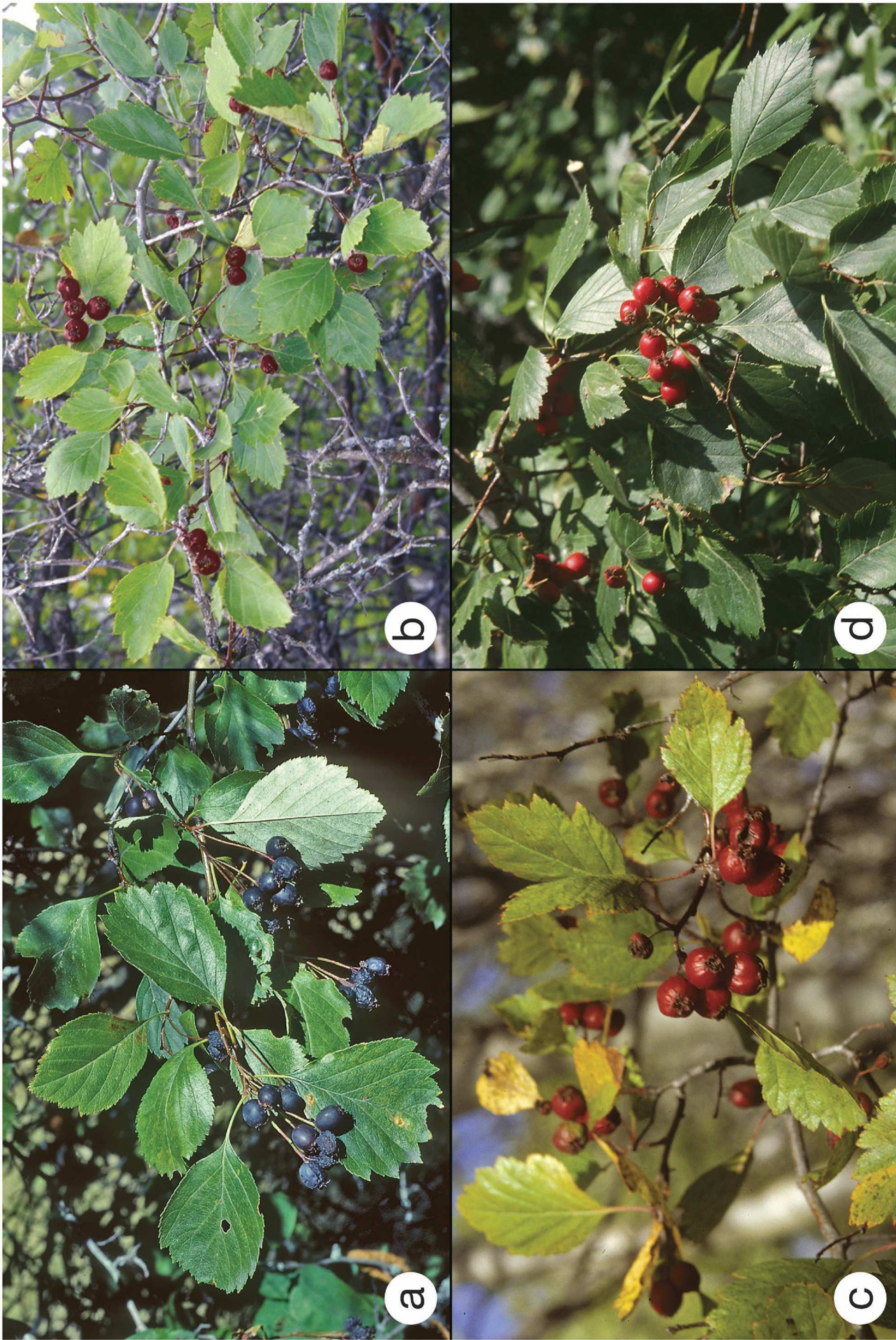


PLATE 7.2. Portraits of fruiting specimens of Cypress Hills *Crataegus*: a) *C. douglasii* (uncollected specimen); Okanagan, BC. b) *C. purpurella* (JBP & O'K 8555); fruit of this species ripens from deep red or burgundy to very deep purple; near Loch Lomond, CHPP, SK. c) *C. rivuloadamensis* (JBP & O'K 8734); Udal Ranch, Adams Creek, SK; d) *C. rivulopugnesis* (JBP 9149); Elkwater, AB.



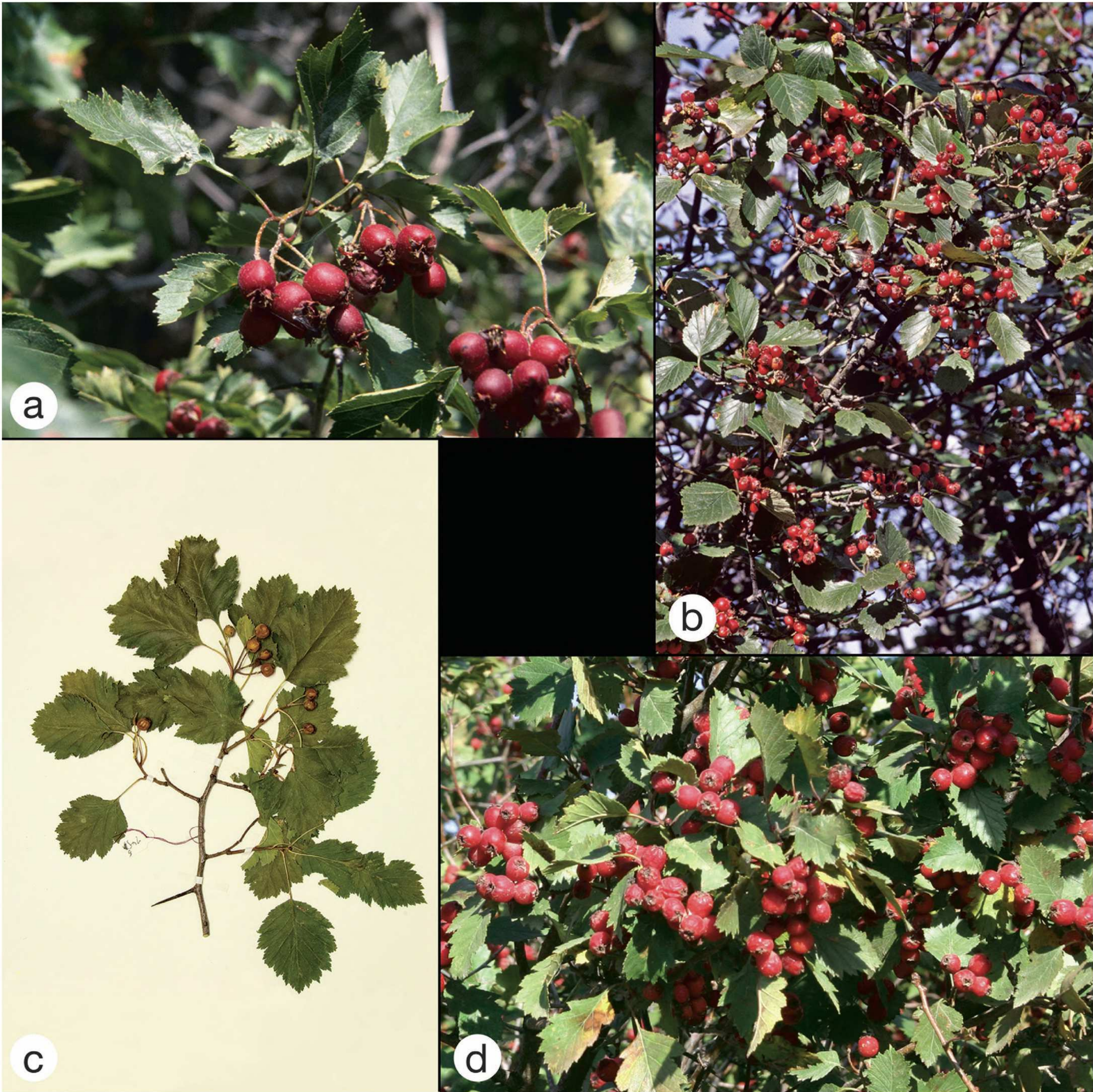


PLATE 7.3. Portraits of fruiting specimens of Cypress Hills *Crataegus*: a) *C. aquacervensis* (JBP & O’K 8791); Elkwater, AB, where this taxon is abundant. b) *C. macracantha* (JBP & O’K 8598); Highwood Mtns., MT; same typical full red color is found in Cypress Hills plants. c) *C. sheridana* (Wyoming specimen in UWO); Cypress Hills plants generally have smaller leaves but of the same general shape. d) *C. rubibracteolata* (JBP 8819); note abundant, tightly clustered, bright red fruit and appressed sepals; near Downie Lake Hutterite Colony, SK.

the Cypress Hills taxa in Table 3. Thus, careful users have an excellent chance of correct identification from good quality median-type material. Nevertheless, due care must be used!

Following is the formal taxonomic treatment with keys to the species in fruit and in flower, detailed protologues for the new taxa, variably detailed treatments for the previously known species and line drawings and range maps (limited to the Cypress Hills) for all taxa treated. The maps on Plate 2 and Figures 1 and 2 provide many defined locations which may be helpful in the inspection of the range maps.

**Conspectus of *Crataegus* taxa recognized in the Cypress Hills**

ser. **Cupressocollinae** J.B. Phipps & O’Kennon



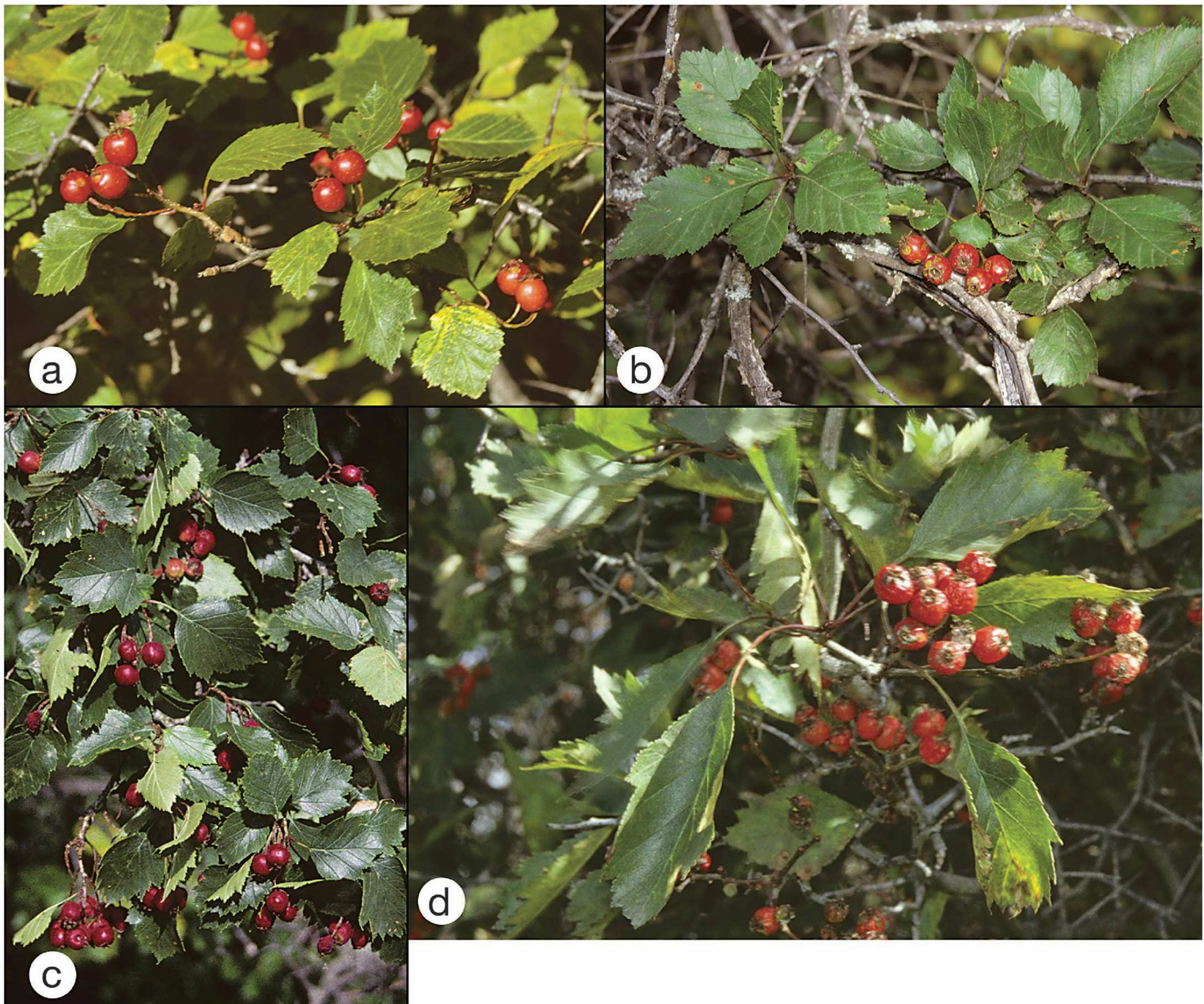


PLATE 7.4. Portraits of fruiting specimens of Cypress Hills *Crataegus*: a) *C. chrysocarpa* (JBP & O'K 8898); this is a typical aspen forest example of the species; Udal Ranch, Adams Creek, SK. b) *C. sheila-hippsiae* var. *saskatchewanensis* (JBP & O'K 8848); aspen woods south of Hay Cr., SK. c) *C. chrysocarpa* (JBP & O'K 8217); specimen displays typical appearance of this species in open prairie; nr. Trans-Canada highway north of Elkwater, AB. d) *C. ursopedensis* (JBP & O'K 8902); Oakes Ranch, south of SK 271.

1. *C. cupressocollina* J.B. Phipps & O'Kennon
- ser. **Douglasianae** (Rehder ex C.K. Schneid.) Rehder
2. *C. douglasii* Lindl.
3. *C. castlegarensis* J.B. Phipps & O'Kennon
- ser. **Purpureofructi** J.B. Phipps & O'Kennon
4. *C. aquacervensis* J.B. Phipps & O'Kennon
- ser. **Montaninsulae** J.B. Phipps & O'Kennon
5. *C. rivuloadamensis* J.B. Phipps & O'Kennon
6. *C. purpurella* J.B. Phipps & O'Kennon
7. *C. rivulopugnensis* J.B. Phipps & O'Kennon
- ser. **Macracanthae** (Loudon) Rehder, and others with red-fruited, eroded nutlets
8. *C. macracantha* Lodd. ex Loudon
9. *C. rubribracteolata* J.B. Phipps & O'Kennon
10. *C. sheridana* A. Nels.
- ser. **Rotundifoliae** Eggl., extended
11. *C. chrysocarpa* Ashe



12. *C. sheila-hippsiae* J.B. Phipps & O'Kennon var. *saskatchewanensis* J.B. Phipps & O'Kennon  
 13. *C. ursopedensis* J.B. Phipps & O'Kennon

## KEY TO CYPRESS HILLS HAWTHORNS IN FRUIT

(NOTE: FULLY RIPE FRUIT COLORS GENERALLY OCCUR AFTER ABOUT SEP 10)

1. Ripe fruit burgundy to black (may be reddish-plum or similar color earlier).
  2. Sides of nutlets clearly eroded.
    3. Thorns 3–5 cm long; fruit ellipsoid, glossy, pendent, frequently in large clusters; calyx-lobes long, prominent, narrow,  $\pm$  spreading \_\_\_\_\_ **1. *C. cupressocollina***
    3. Thorns 1.5–5.5 cm long; fruit ellipsoid to suborbicular or turbinate, not especially glossy, seldom both pendent and in large clusters, size variable; calyx-lobes short to longer, relatively broad.
      4. Thorns 1.5–3 cm long; calyx-lobes very short,  $\pm$  appressed; fruit in early September purple to black.
        5. Fruit dead black by 1<sup>st</sup> September, generally  $\pm$  ellipsoid; infructescence branches glabrous; plant habit tall and thin; double and triple thorns not observed \_\_\_\_\_ **2. *C. douglasii***
        5. Fruit purplish or vinous in early September, very dark purple to almost black later, subglobose; infructescence branches variably pilose (difficult to see in some specimens); plant habit generally dense and twiggy; double and triple thorns often present in small numbers, occasionally abundant \_\_\_\_\_ **3. *C. castlegarensis***
      4. Thorns 3.0–5.5 cm long; calyx-lobes a little larger, recurved rather than appressed; fruit in early September burgundy \_\_\_\_\_ **6. *C. aquacervensis***
  2. Sides of nutlets  $\pm$  plane to very shallowly concave.
    6. Thorns usually 1.5–3(–4) cm long, usually  $\pm$  stout, often  $\pm$  straight and conical; pubescence of infructescence  $\pm$  dense; fruit  $\pm$  pubescent, reddish plum to burgundy \_\_\_\_\_ **4. *C. rivuloadamensis***
    6. Thorns 2.75–5.0 cm long, slender, nearly always recurved; infructescence pubescence nil to moderate: fruit reddish or deep purple, glabrous to somewhat pubescent.
      7. Thorns mainly 2–3.0 cm long; leaves (3–)4–6-veined per side, often only 1.0–1.25 times as long as wide; fruit deep purple fully ripe, burgundy earlier \_\_\_\_\_ **6. *C. purpurella***
      7. Thorns 2.5–3.5(–4) cm long; main lateral veins of leaf usually 5–8 per side; leaves generally at least 1.5  $\times$  as long as wide; fruit deep red fully ripe, red earlier \_\_\_\_\_ **7. *C. rivulopugnensis***
1. Ripe fruit bright to dull red, occasionally somewhat plum red.
  8. Nutlets distinctly eroded laterally.
    9. Leaves shallowly lobed, ovate to broad elliptic in general shape; veins impressed at maturity; calyx-lobes fairly deeply glandular-serrate; petioles eglandular \_\_\_\_\_ **8. *C. macracantha***
    9. Leaves shallowly to quite deeply lobed; veins not significantly impressed at maturity; calyx-lobes glandular but barely serrate; petioles glandular.
      10. Leaves ovate in general shape; lobes fairly deep and sharply acute; thorns stout, usually 3.5–5.5(–7) cm long; calyx-lobes normally appressed to fruit \_\_\_\_\_ **9. *C. rubibracteolata***
      10. Leaves relatively broader, some often as long as wide; lobes shallow, their tips at most acute; thorns more slender, usually 3–5 cm long; calyx-lobes in fruit usually  $\pm$  spreading \_\_\_\_\_ **10. *C. sheridana***
  8. Nutlets  $\pm$  plane laterally.
    11. Leaf-blades 3–5 cm long; thorns slender to moderately stout, usually 3–4 cm long.
      12. Thorns as above, or stouter and longer, 3–5 cm long (anthers ivory).
        13. Infructescences variably pubescent; ca. 10 stamen bases \_\_\_\_\_ **11. *C. chrysocarpa***
        13. Infructescences glabrous; ca. 20 stamen bases \_\_\_\_\_ **12. *C. sheila-hippsiae* var. *saskatchewanensis***
      12. Thorns slender, recurved, 2–4 cm long (anthers pink) \_\_\_\_\_ **7. *C. rivulopugnensis***
    11. Leaf-blades to 7 cm long; thorns stout, usually  $\pm$  recurved, 4–7 cm long.
      14. Blades rhombovate, usually flat or concave \_\_\_\_\_ **13. *C. ursopedensis***
      14. Blades ovate to broad elliptic, often convex \_\_\_\_\_ **13a. (see note after sp. 13)**

## KEY TO CYPRESS HILLS HAWTHORNS IN FLOWER

1. Anthers pink.
  2. Petioles eglandular; calyx-lobe margins distinctly glandular-serrate \_\_\_\_\_ **8. *C. macracantha***
  2. Petioles glandular (glands may be quite small).
    3. Thorns 1.5–3 cm long, usually straight.
      4. Inflorescence glabrous \_\_\_\_\_ **2. *C. douglasii***
      4. Inflorescence thinly to densely pubescent.



5. Flowers 12–15 mm diam.; leaves generally not sharply lobed \_\_\_\_\_ **3. C. castlegarensis**  
 5. Flowers 17–21 mm diam.; leaves sharply lobed \_\_\_\_\_ **5. C. rivuloadamensis**
3. Thorns 3–5 cm long, usually recurved.  
 6. Flowers 17–19 mm diam; inflorescences moderately hairy; thorns stout, 3.0–5.5 cm long \_\_\_\_\_ **4. C. aquacervensis**
6. Flowers 11–17 mm diam.; inflorescences subglabrous to somewhat hairy; thorns slender, 3–3.5 cm long.  
 7. Leaves (3–)4–6 veined per side; blades mostly 2.5–4.0 cm long (fruit purple) \_\_\_\_\_ **6. C. purpurella**  
 7. Leaves 5–8 veined per side; blades mostly 3–5 cm long (fruit red) \_\_\_\_\_ **7. C. rivulopugnensis**
1. Anthers white to cream.  
 8. Two to five year old twigs often orange-brown; bracteoles numerous, of varying size and form,  $\pm$  eglandular \_\_\_\_\_ **1. C. cupressocollina**
8. Two to five year old twigs gray or dull brown; bracteoles sparse to numerous, of not greatly varying form, margins glandular.  
 9. Bracteoles in young inflorescence strongly rust-red; expanding bud-scales red \_\_\_\_\_ **9. C. rubribracteolata**  
 9. Bracteoles in young inflorescence much paler though may be tinted pinkish or reddish, particularly towards the edges; expanding bud scales colored or not, but never richly reddish throughout.  
 10. Flowers 20 mm diam.; thorns stout, 4–7 cm long usually recurved.  
 11. Many leaves at early anthesis very small (<3 cm long), flabellate, with very prominent veins; blades  $\pm$  flat on expansion, or slightly keeled \_\_\_\_\_ **13. C. ursopedensis**  
 11. Leaves not unusually small at early anthesis, > 4 cm long, not flabellate, venation not especially prominent; many blades often convex \_\_\_\_\_ **13a.** (see note after sp. 13)
10. Flowers 15–18 mm diam.; thorns slender to stouter, mainly 3–4(–5) cm long, recurved or  $\pm$  straight.  
 12. Pedicels subglabrous; stamens 20 \_\_\_\_\_ **12. C. sheila-phippisiae**  
 12. Pedicels pubescent; stamens ca. 10.  
 13. Blades often only 0.8–1.0  $\times$  as wide as long; many with widest point near centre; hypanthium densely pubescent \_\_\_\_\_ **10. C. sheridana**  
 13. Blades 0.6–0.8  $\times$  as wide as long, broadest near base; hypanthium only densely pubescent in a few aberrant individuals \_\_\_\_\_ **1. C. chrysocarpa**

series **Cupressocollinae** J.B. Phipps & O’Kennon, ser. nov. TYPE SPECIES: *Crataegus cupressocollina* J.B. Phipps & O’Kennon.

Similis ser. *Purpureofructuum* his proprietatibus exceptis: Planta gracilis; spinae longiores (ad 7 cm.), curvatae, tenues. Bracteolae paucae-glandulares vel fere eglandulares, et interdum ut videtur se versantes gradatim in squamas gemmarum. Stamina 10, antheris albis. Fructus in fasciculis pendulis, nitentes, atropurpurei, nigri in maturitate plena, purpurei in juventate; lobi calycis  $\pm$  patententes et acuminati ubi non erosi.

Like ser. *Purpureofructi* except: Plant slender; thorns longer (to 7 cm), curved, slender. Bracteoles few-glandular, or nearly eglandular and in some cases apparently grading into bud-scales. Stamens 10; anthers white. Fruit in pendulous clusters, glossy, deep purple, nearly black when fully ripe, purple younger (initially plum-red); calyx-lobes  $\pm$  patent and pointed when not eroded.

A sole species, below.

**1. Crataegus cupressocollina** J.B. Phipps & O’Kennon, sp. nov. (**Plates 6.2a, 7a,b; Fig. 6**). TYPE: CANADA. SASKATCHEWAN: Cypress Hills, Maple Creek Rur. Mun., thickets near Hay Creek, alt. 889 m 23 May 2003, J.B. Phipps & R. O’Kennon 8501 (HOLOTYPE: UWO; ISOTYPES: CAN, DAO, MO, SASK, TRT).

Frutex,  $\pm$  erectus, 2.5–6 m altus; spinae 3–5(–7) cm longae,  $\pm$  numerosae vel paucae, ad duos annos nitenter atro-brunneae,  $\pm$  rectae vel  $\pm$  valde curvatae, mediae crassitudinis; ramuli extensi primo sparsim pilosi, virido-rubri, annotini nitenter rubro-brunnei vel atro-brunnei; veteriores aurantiaco-brunnei partiale tecti cum cinereis. Folia decidua; petioli 1–1.5 cm longi in anthesi, leviter pubescentes in juventute, pauco-glandulosi; laminae 3–6(–8) cm longae in anthesi, majores in maturitate,  $\pm$  ovatae vel late-ellipticae in forma generali; apex acutus, basis late cuneata; latera 3–4 lobis acutis vel aliquantum rotundatis; max. IFI 15%; venatio craspedodroma, 3–4 nervis per latus in foliis parvioribus, 5–7 in foliis majoribus; margines cum dentibus parvis, numerosis, illis glandularis minimum primo; adpresso-pilosae adaxialiter in iuventute,  $\pm$  glabrescentes, fere glabrae subter sed aliquantulum pilosae axialiter secundum nervum centalem;  $\pm$  tenues. Inflorescentiae 5–15 floratae; rami sparsim vel moderate dense pilosi, ferentes numerosas, caducas, membranaceas, lineares, pallide brunnescentes, usiter fere eglandulares bracteolas. Flores 15–18 mm diam.; hypanthium extrinsecum glabrum; lobi calycis pilosi adaxialiter, glabri abaxialiter, triangulares, marginibus subtiliter glandulo-serratis et  $\pm$  forte anthocyaninis; stamina 0–10





FIG. 6. Line drawing of *C. cupressocollina*. Specimens used: Phipps & O’Kennon 8488, 8489, 8505, 8957 (flowering); Phipps & O’Kennon 8618 (fruiting). Young inflorescences shown to indicate presence of abundant caducous bracteoles. Mag top left is a laminate upper bud-scale in lower inflorescence of JBP & O’K 8469. Other mags show whole leaf abaxial surface, pubescence on part young leaf adaxial surface, calyx-lobe, fruit and nutlets. S. Laurie-Bourque del.; scale bars equal 1 cm.



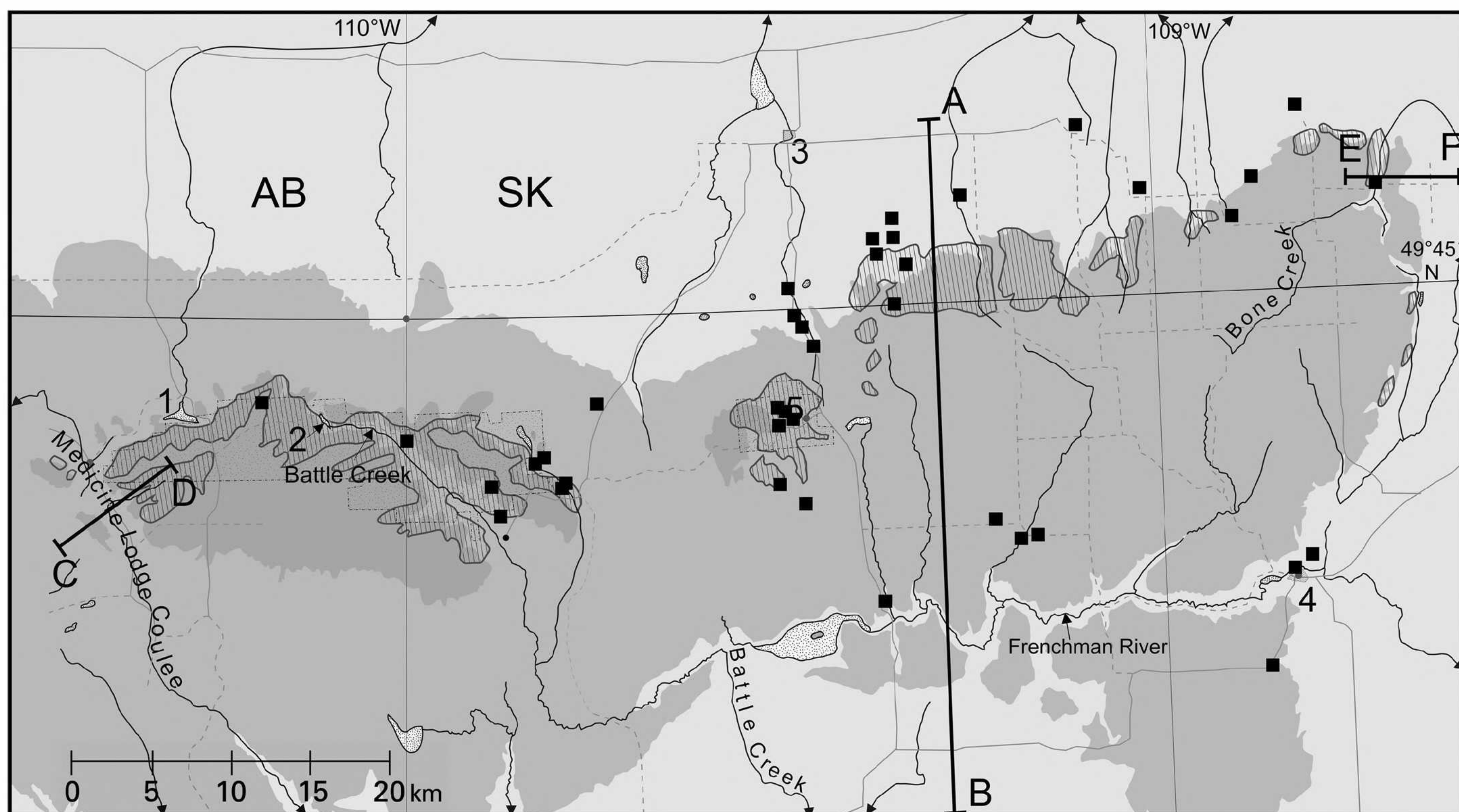


FIG. 7. Map of *C. cupressocollina* distribution in the Cypress Hills. Base map same as for Fig. 2.

(vide disputationem), antheris albis; styli 3–5. Infructescentia cum ramis pendulis; fructus 7–10 mm diam., usiter perfecte ellipsoidei, vinosi in Augusto exeunte–Septembro ineunte, atropurpurei in Septembro exeunte, glabri; lobi calyci angusti, ± acuminati, patentes; pyrenae 3–5, dorsaliter vadositer sulcatae, lateribus cum foveis irregularibus vel cicatricibus diagonalibus.

Bush, ± more or less erect, 2.5–6 m tall; thorns 3–5(–7) cm long, fairly numerous to few, at 2 yrs shiny blackish-brown, ± straight to quite strongly recurved, medium thickness; extending twigs at first sparsely pilose, greenish red, at 1 yr shiny, deep to reddish-brown, older orange-brown overlaid with gray. Leaves deciduous; petioles thinly pubescent young, 1–1.5 mm long at anthesis, with a few glands; laminas 3–6(–8) cm long at anthesis, larger at maturity, ± ovate to broad-elliptic in general shape, acute at the tip, broadly cuneate at the base, sides with 3–4 pointed to somewhat rounded lobes, max LII 15%; venation craspedodromous, 3–4 veins/side in smaller leaves, 5–7 in larger; margins with numerous small teeth, gland-tipped at least at first, appressed hairy adaxially young, nearly glabrous below except for some axillary pilosity along the midvein; thinish. Inflorescences 5–15 flowered, the branches thinly to moderately densely pilose, bearing numerous, caducous, membranous, linear, pale brownish, generally nearly eglandular bracteoles. Flowers 15–18 mm diam.; hypanthium externally glabrous; calyx-lobes adaxially pilose, abaxially glabrous, triangular, margins finely glandular-serrate, ± richly anthocyanic; stamens 0–10 (see discussion), anthers white; styles 3–5. Infructescence with pendulous branches; fruit 7–10 mm diam., generally nearly perfectly ellipsoid, burgundy in late August to early September, glabrous; calyx-lobes narrow, ± acuminate, spreading; nutlets 3–5 dorsally shallowly grooved, sides ± irregularly pitted or scarred.

*Common name.*—Cypress Hills Hawthorn.

*Distribution (Fig. 7).*—Found throughout the Cypress Hills of Saskatchewan in suitable habitats together with other species of *Crataegus*. In Alberta it is only known from a few specimens in the Battle Creek valley and one from Spruce Coulee Road. Outside the Cypress Hills we have recorded it from a couple of specimens in the Bear's Paw Mountains, Montana. The first known collection is by Breitung (1947), who called it *C. columbiana*, in the Cypress Hills Provincial Park, Saskatchewan. Eleven other collections were made pre-dating any of ours. These had been generally ascribed to *C. douglasii* but very substantial differences exist, see below, keys and box plots. In fact, it was the first author's observation of this interesting form of '*C. douglasii*' in 1998 at SASK that provoked our first visit to the Cypress Hills.



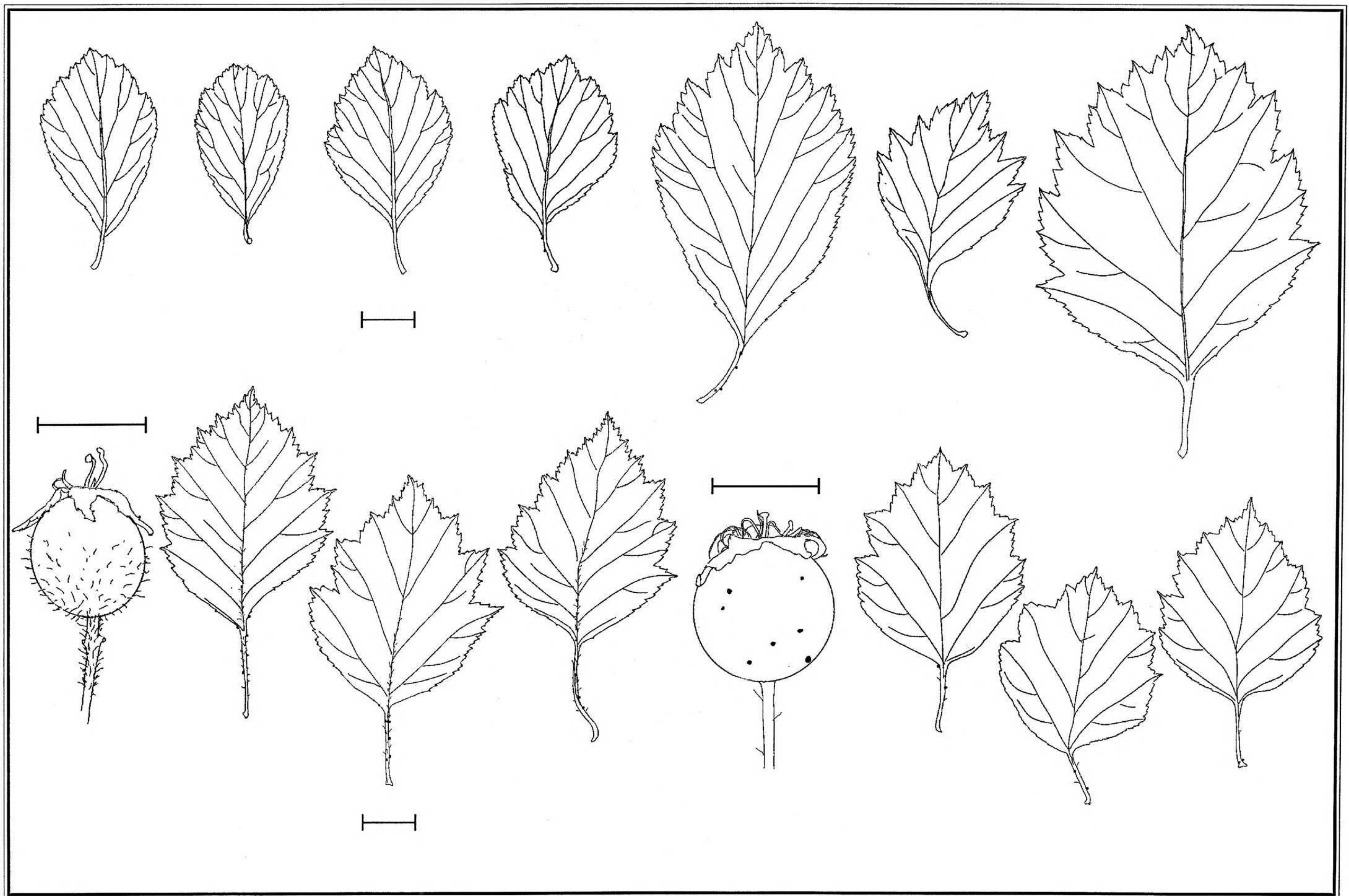


FIG. 8. Line drawing of leaf spectra of *C. douglasii* (upper), and *C. chrysocarpa* (lower). Specimens used: *C. douglasii*—left, unlobed common form in Cypress Hills, Phipps & O'Kennon 8233 (UW0); right, sharply lobed form, Phipps & O'Kennon 8225 (UW0); *C. chrysocarpa*—left, very lanate form, rare in the Cypress Hills, Phipps & O'Kennon 8237 (UW0); right, less pubescent form, common in the Cypress Hills, Phipps & O'Kennon 8899 (UW0). S. Laurie-Bourque del.; scale bars = 1 cm.

For a new species in a fairly well collected region *C. cupressocollina* is surprisingly distinctive and moreover very common in many parts of the Cypress Hills. It is a tall, willowy, upright species, distinct in leaf form, with characteristic thorns and two to five year old orange-brown bark. The flower closely resembles that of species in ser. *Douglasianae* except in anther colour and the plant is dark-fruited with laterally eroded nutlets like all members of that series but has much longer thorns (Fig. 5a.1). The ripe fruit of *C. cupressocollina* is quite glabrous and is plum-red to purple-brown in late August after which it ripens to a glossy purple-black. The large, pendulous clusters of fruit at once draw attention, as do, in flower, the reddish tips of the calyx lobes and the soft red-brown of the often nearly eglandular bracteoles approaching Dvorsky type 1c (Plate 6.1b). The bracteoles in this species appear to have some transition to the bud scales. The latter, when expanding, are also rather strikingly colored, although less so than in *C. macracantha*. *Crataegus cupressocollina* fits no existing series as currently conceived, but it might be placed in an expanded ser. *Purpureofructi*. Therefore, we are placing it in its own series, *Cupressocollinae*. The specific epithet refers to the Cypress Hills where it is far more abundant than anywhere else.

*Crataegus cupressocollina* is, by a small margin, the first to flower of the local species. In spring 2003 extensive damage was observed to reproductive parts: black and shrivelled styles, blackened anthers and reduced stamen count (instead of being usually  $\pm 5$  or  $\pm 10$  as expected), which was probably a consequence of an extended period of low temperatures earlier in May which included values of  $-15^{\circ}\text{C}$  at Cypress Hills Provincial Park meteorological station.

series **Douglasianae** (Rehder ex C.K. Schneid.) Rehder. TYPE SPECIES: *Crataegus douglasii* Lindl.



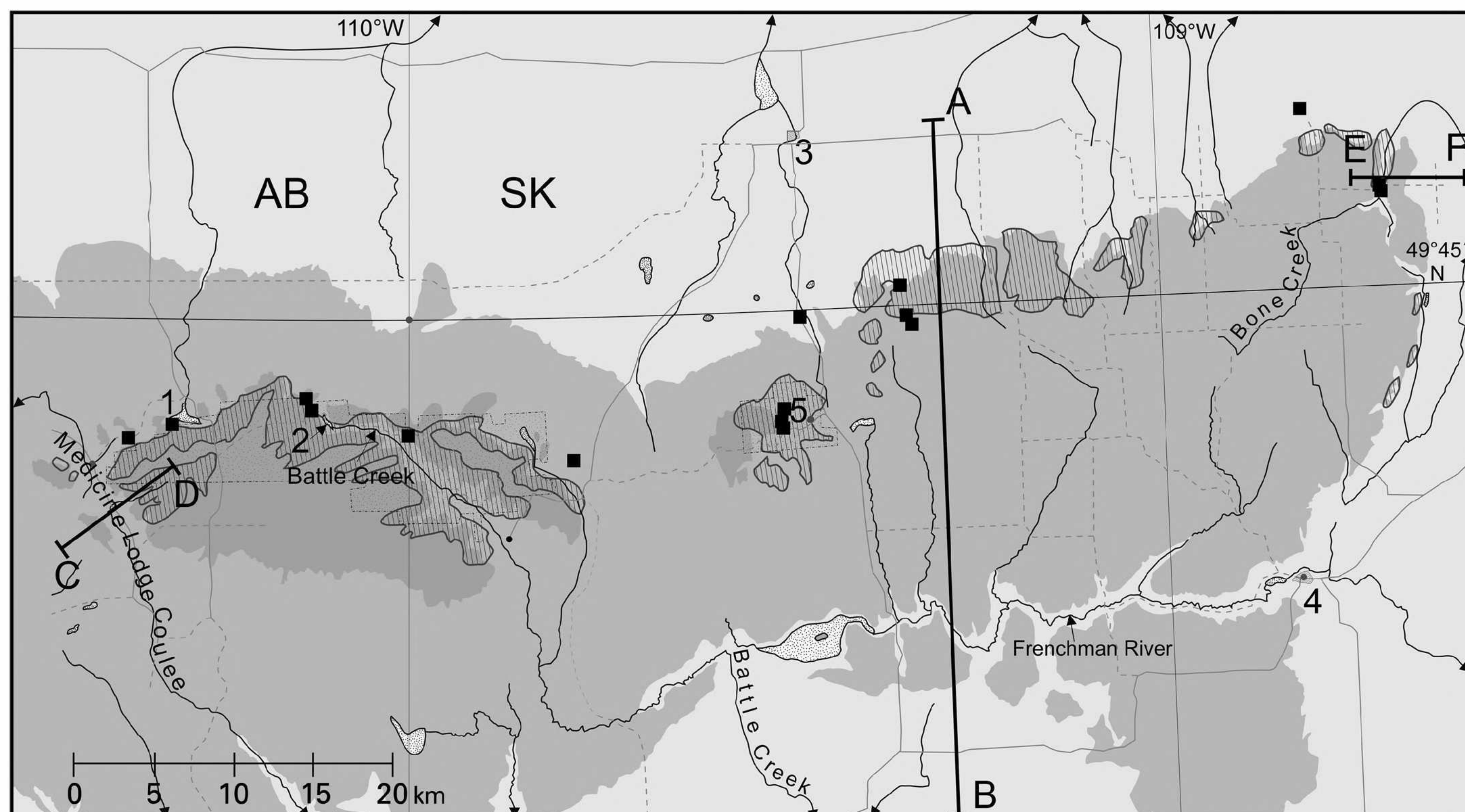


FIG. 9. Map of *C. douglasii* distribution in the Cypress Hills. Base map same as for Fig. 2.

Bushes or small trees; thorns very short (1 cm) to short (3 cm). Flowers small-medium (12–18 mm diam.), pink-anthered. Fruit smallish (6–10 mm diam.), when ripe very dark purple or black, paler, but not red when younger, calyx lobes short, blunt,  $\pm$  appressed, nutlets with pitted sides.

Five species, mainly western montane North America, one disjunct to Great Lakes. The two species here are readily distinguished in the Cypress Hills by inflorescence pubescence and fruit shape (Fig. 5c) and to some extent by thorn characters and facies.

**2. *Crataegus douglasii* Lindl., Edward's Bot. Reg. 8:1810. 1836. (Plate 7.2a; Fig. 8, upper).**

An often somewhat upright bush in the Cypress Hills, to 6–7 m; thorns short; inflorescence glabrous; anthers pink; ripe fruit black. Other characteristics as key. A detailed description may be found in Phipps and O'Kennon (2002) and a further color illustration in Phipps et al. (2003).

*Common names.*—Black Hawthorn, Douglas Hawthorn.

*Distribution (Fig. 9).*—Widespread west of the Rocky Mountains, discontinuous in higher land through the southern prairies and northern Great Plains and in lowlands bordering the upper Great Lakes. *Crataegus douglasii* is locally common in the Cypress Hills in mesic habitats, particularly below aspen. It is often the only hawthorn in mesic north-facing high altitude draws over 1200 m and is rare to absent in drier hawthorn habitats or lower altitude thickets.

In the Cypress Hills, *C. douglasii* is a more willowy and lanky plant than *C. castlegarensis*. Two leaf forms exist in the Cypress Hills, one with nearly unlobed blades, the other and rarer form with sharp and deep lobes.

**3. *Crataegus castlegarensis* J.B. Phipps & O'Kennon, Sida 20:121. 2002. (Plate 7.1c, d).**

Distinguishing characters per key. A detailed description and illustration may be found in Phipps and O'Kennon (2002).

*Common name.*—Castlegar Hawthorn.

*Distribution (Fig. 10).*—*Crataegus castlegarensis* has a similar distribution to *C. douglasii* except that it



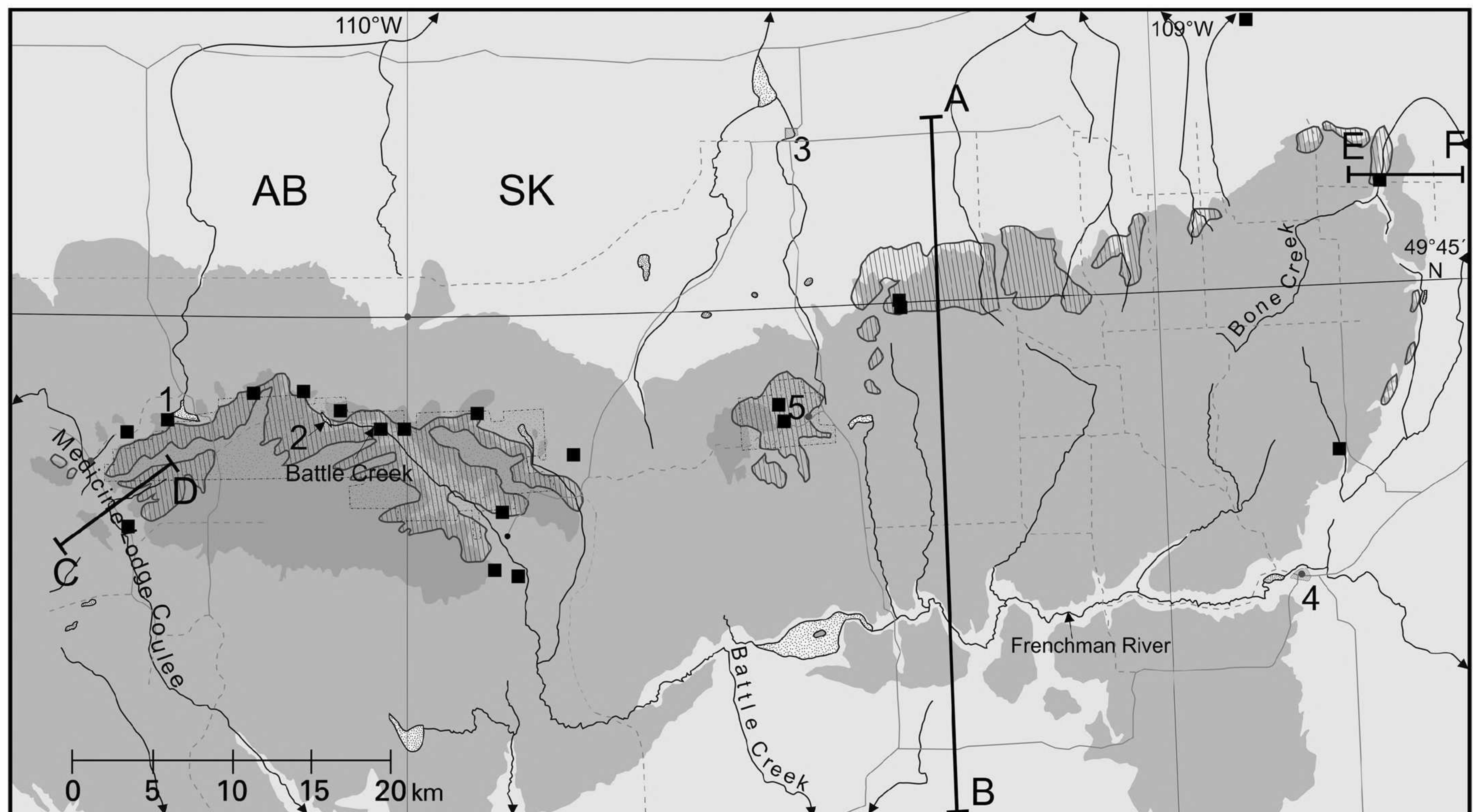


FIG. 10. Map of *C. castlegarensis* distribution in the Cypress Hills. Base map same as for Fig. 2.

is not found in the Great Lakes region. The distribution in the Cypress Hills is concentrated above 1100 m and the species is perhaps more heliophilous than *C. douglasii*.

This is the species that most likely has double, triple or even quadruple thorns. Sometimes the majority of thorns on the twigs are of this type but more likely the character will just be seen on a number of twigs or even not observed. In the Cypress Hills this species is usually a much denser bush than *C. douglasii* and the thorns average slightly longer than in that species (Fig. 5a.1) although there is some overlap.

series **Purpureofructi** J.B. Phipps & O'Kennon. TYPE SPECIES: *Crataegus okanaganensis* J.B. Phipps & O'Kennon.

Medium-large bushes to small trees; thorns usually moderately short (2.5–5 cm), somewhat stout. Flowers 12–16 mm diam., stamens usually 10, anthers pink. Fruit often brilliant red when subripe, alternatively vinaceous, deep red-purple to purple-black ripe; fruiting calyxes erecto-patent, somewhat accrescent; nutlets with  $\pm$  pitted sides.

Seven species, western montane North America.

**4. *Crataegus aquacervensis*** J.B. Phipps & O'Kennon, sp. nov. (**Plate 7.2c; Fig. 11**). TYPE: CANADA. ALBERTA: Cypress Hills Provincial Park, near entrance gate to Horseshoe Canyon, Elkwater, alt. 1302 m, 7 Jun 2005, J.B.Phipps & R.O'Kennon 8989 (HOLOTYPE: UWO; ISOTYPES DAO, ALTA, UAC).

Frutices, dense ramosi, 2–4 alti; ramuli extensi cum plurimo anthocyanino, fere glabri; annotini mediocriter-vel atro-brunnei; veteriores cinerei vel atrocineri; spinae usiter numerosae, 3–5.5(–6.5) cm longae,  $\pm$  validae, plerumque recurvatae, in secundum annum nitenter peratro-castaneae. Folia decidua; petioli 30–40% longitudinis laminae, pubescentes solo in sulco adaxiali, ferentes aliquot sessiles glandes; laminae 3–3.5 cm longae in anthesi, 4–7 cm longae in maturitate, ovatae vel trullato-ovatae vel late ellipticae in forma generali; bases cuneatae vel late-cuneatae; apices acuti; lobi acuti (2–)3–4 per latus, max. IFI 15–25%; margines cum numerosis dentibus parvis acutis vel subacutis; venatio craspedodroma, distincte impressa supra, venis (3–)4–5 per latus; superficies adaxiales  $\pm$  dense appresso-scabro-pubescentes, abaxiales plerumque glabrae praeter interdum densam tenuem pubescentiam in lateribus venarum. Inflorescentiae 5–12 floratae; rami aliquantum sparsim vel moderate dense pubescentes, ferentes caducas, membranaceas, pallide brunneas,  $\pm$  lineares, glandulo-marginatas bracteolas. Flores 15–18 mm diam.; hypanthium subglabrum vel sparsim vel moderate pubescens; lobi calycis glandulo-denticulati vel-serrati, 2–5 mm longi, triangulares, glabri supra et infra, pallidi cum aliquot anthocyanis vel pallidebrunnei; petala alba,  $\pm$  circularia; stamina ca. 10, antheris pallide roseis vel subroseis; styli 3–4. Pedicelli fruticantes subglabri vel moderate dense pubescentes. Fructus 9–12 mm alti, ellipsoidei vel late ellipsoidei vel turbinati, rubro-prunini primo, sordido-prunini in pleno matu-



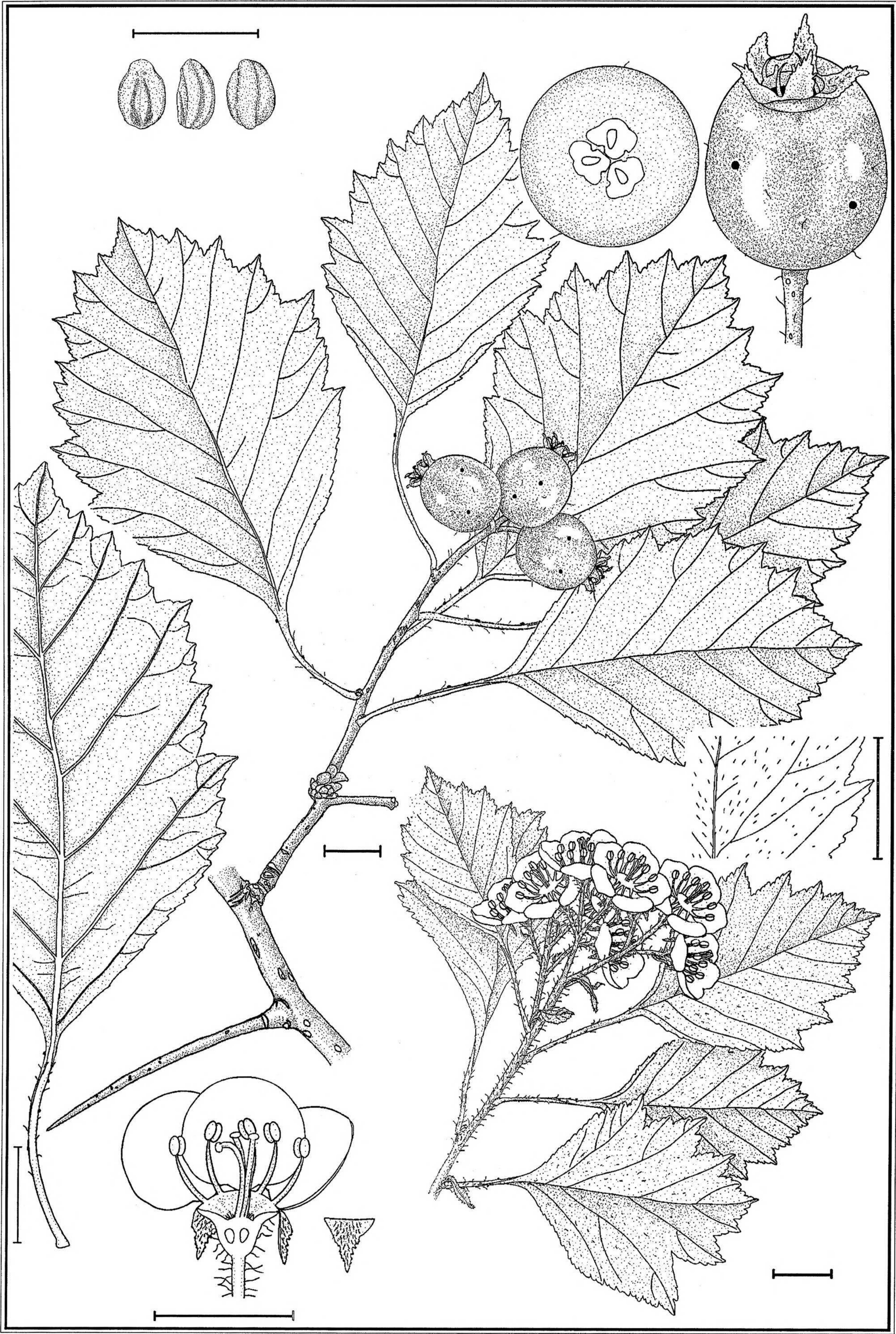


FIG. 11. Line drawing of *C. aquacervensis*. Specimens used: Phipps & O'Kennon 8753, 8769 (flowering); Phipps & O'Kennon 8529, 8549, 8803 (fruiting). Mags show whole leaf abaxial surface, pubescence on part young leaf adaxial surface, flower section and calyx-lobe, fruit and nutlets. S. Laurie-Bourque del.; scale bars equal 1 cm.



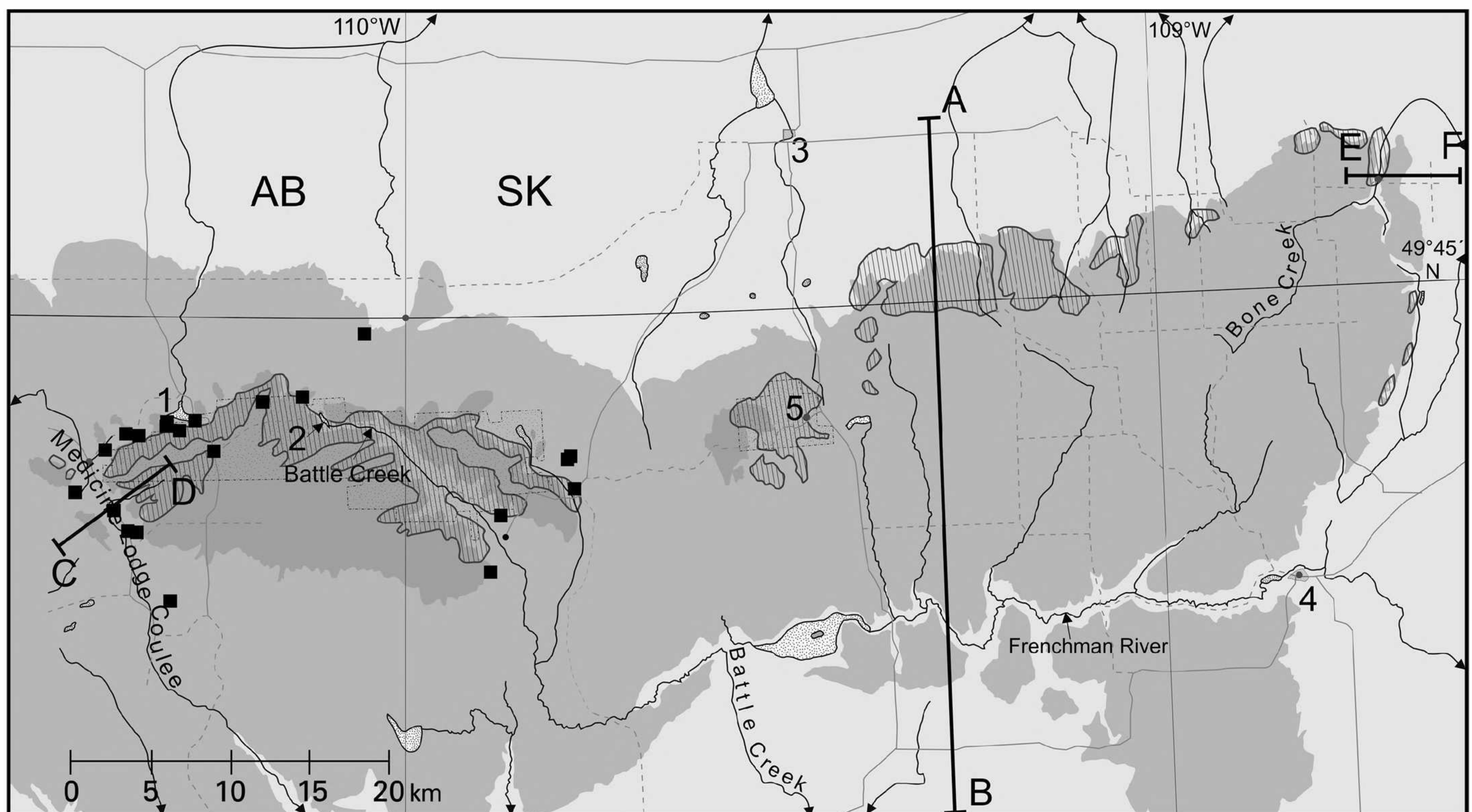


FIG. 12. Map of *C. aquacervensis* distribution in the Cypress Hills. Base map same as for Fig. 2.

ritate, subglabri vel moderate pubescentes; lobi calycis typice erecto-recurvati, 2.5–4 mm longi; pyrenae 3–4(–5), faciebus lateralibus varie sulcatis, quamquam saepe vadositer.

Densely branched shrubs, 2–4 m tall; extending shoots anthocyanin-rich, nearly glabrous; at one year medium to darker brown; older gray to dark gray; thorns generally abundant, 3–5.5(–6.5) cm long,  $\pm$  stout, usually recurved, at two years shiny, very dark red brown. Leaves deciduous; petioles 30–40% length of blade, pubescent only in the adaxial sulcus, bearing a variable number of sessile glands; blades 3–3.5 cm long at anthesis, 4–7 cm at maturity, ovate or trullate-ovate to broad-elliptic in general shape, base cuneate to broad cuneate, apex acute; lobes (2)–3–4, sharp, per side, max LII 15–25%; margins with many small acute to subacute teeth; venation craspedodromous, distinctly impressed, (3–)4–5 per side; adaxial surface  $\pm$  densely appressed scabrous=pubescent; mostly glabrous abaxially except for occasional dense fine pubescence along the sides of the veins. Inflorescences 5–12 flowered; branches somewhat thinly to moderately densely pubescent, bearing caducous, membranous, light brown,  $\pm$  linear, gland-margined bracteoles. Flowers 15–18 mm diam.; hypanthium subglabrous to thinly or moderately pubescent; calyx-lobes denticulate to glandular serrate, 2.5 mm long, triangular, glabrous on both sides, pale with some anthocyanins or light brown; petals white,  $\pm$  circular; stamens ca. 10, anthers pale pink or pink, styles 3–4. Fruiting pedicels subglabrous to moderately densely pubescent. Fruit 9–12 mm high, ellipsoid to broadly ellipsoid or turbinate, reddish-plum early, dull purple when fully ripe, subglabrous to moderately densely pubescent; calyx-lobes typically erecto-recurved, 2.5–4 mm long; nutlets 3–4(–5), sides variably grooved, though often shallowly.

*Common name.*—Elkwater Hawthorn.

*Distribution (Fig. 12).*—*Crataegus aquacervensis* is widely distributed in the northern part of the Cypress Hills from the Adams Creek area and Fort Walsh, north and west. The first record seems to be by McCalla (see cited specimens) from near Elkwater, Alberta, in 1930.

*Crataegus aquacervensis* is most superficially similar to *C. rivuloadamensis*, *C. rivulopugensis* and *C. purpurella*, although it differs from all three in the  $\pm$  eroded lateral faces of the nutlets and differs from the last two in the longer and stouter thorns, greater hairiness of inflorescence and flower, and from *C. rivuloadamensis* in the larger, curved thorns. All four have different fruit color. *Crataegus purpurella* ripens



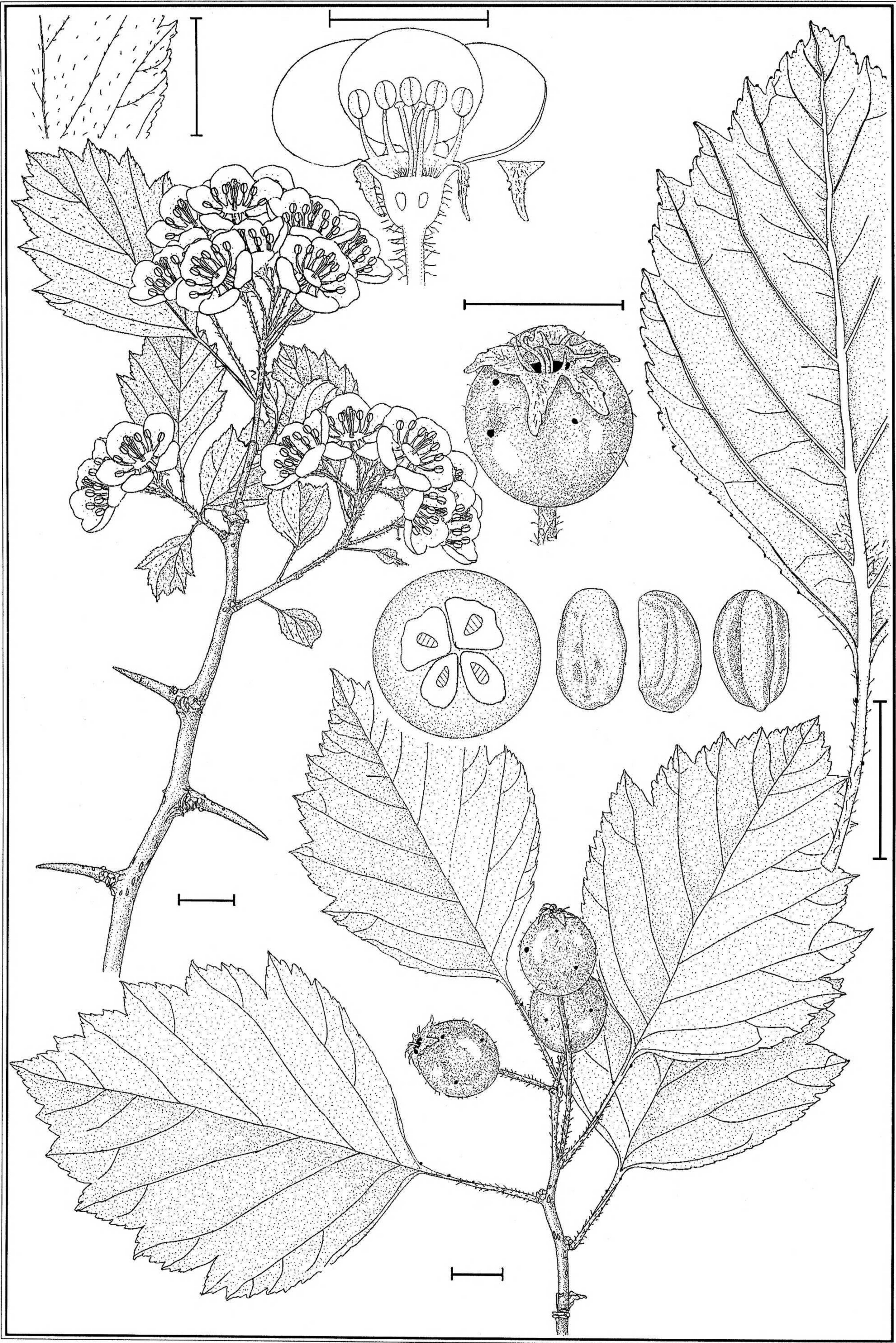


FIG. 13. Line drawing of *C. rivuladamensis*. Specimens used: Phipps & O'Kennon 8739, 8963 (flowering); Phipps & O'Kennon 8224, 8543, 8907 (fruiting). Mags show whole leaf abaxial surface, pubescence on part young leaf adaxial surface, flower section and calyx-lobe, fruit and nutlets. S. Laurie-Bourque del.; scale bars equal 1 cm.



from burgundy to deep purple, *C. rivulopugnensis* is essentially red, *C. rivulodamensis* is deep red to rich burgundy and *C. aquacervensis* ripens from deep red to deep purple. *Crataegus aquacervensis* is distinctive also on account of possessing clearly eroded sides to its nutlets and for this reason might be best placed in series *Purpureofructi*. *Crataegus aquacervensis* is, however, not a particularly typical member of this series. The species is named for the settlement of Elkwater in the north-west of the Cypress Hills near where *C. aquacervensis* is particularly abundant.

Series **Montaninsulae** J.B. Phipps & O'Kennon, ser. nov. TYPE SPECIES: *Crataegus purpurella* J.B. Phipps & O'Kennon.

Frutices vel interdum arbores parvae; spinae typice tenues, longitudinis mediocris (2–4 cm). Folia adaxialiter subglabra, dissimilia plurimarum specierum *Crataegi* in regione. Stamina 10, antheris roseis. Fructus mediocris magnitudinis, purpurei vel rubri, pyrenarum lateralis faciebus levibus vel leviter concavis.

Shrubs or occasionally small trees; thorns typically slender, of medium length (2–4 cm). Leaves subglabrous above, unlike most *Crataegus* species in the region. Stamens 10, anthers pink. Fruit of medium size, purple or red; sides of nutlets smooth or slightly concave.

The description covers two species, *C. purpurella* and *C. rivulopugnensis*; *C. rivulodamensis*, much hairier, with large fruit and frequently, short, stout,  $\pm$  conic thorns, is also treated here but may not be very closely related. All three are, on present knowledge, Cypress Hills endemics.

**5. *Crataegus rivulodamensis*** J.B. Phipps & O'Kennon, sp. nov. (**Plate 7.3a; Fig. 13**). TYPE: CANADA. ALBERTA: Cypress Hills, Cypress Hills Provincial Park, eastern slopes Medicine Lodge Coulee, Murray Hill Road, 1182 m, 15 Sep 2004, J.B. Phipps & R. O'Kennon 8800 (HOLOTYPE: UWO; ISOTYPES: CAN, DAO, ALTA, SASK, TRT).

Frutex, late-ramificatus, vel arbor parva, 2.5–4(–5) m alta; spinae 1.5–2.5(–3) cm longae,  $\pm$  rectae (breviores conicae et crassae) politae per atrorubro-brunneae post secundum annum, veteriores atrocineriae; ramuli prorecti pubescentes, rubentes, atrovirides; annu-tini nitenter atrorubro-brunnei; ramuli post secundum annum atrorubri et cinerei; veteriores cinerei. Folia decidua; petioli 25–35% longitudinis laminae, tenuissimi, dense pubescentes in sulco adaxiali, eglandulares vel cum paucis glandibus sessilibus, vel cum glandibus stipitatis ad basem; laminae magnitudinis dimidio in anthesi, in maturitate 4–8 cm longae,  $\pm$  ellipticae vel late-ellipticae vel rhombellipticae in forma generali; bases cuneatae vel anguste-cuneatae; apices cuneatae; lobi 2–4 per latus, max. IFI (0–)5–20(–25%), apicibus subacutis vel late cuspidatis; margines cum dentibus crenato-serratis vel serratis; venatio craspedodroma, paribus venarum principalium lateralium 4–6, vix impressis; pubescentia adaxialis  $\pm$  dense et persistense appresso-scabra; pubescentia abaxialis appresso-scabra per venas, superficiebus glabris vel cum dispersis pilis in juventute. Inflorescentiae 4–10 floratae; rami dense pubescentes, ferentes caducas, membranaceas,  $\pm$  rubras, angustas, dense glandulo-marginatas bracteolas. Flores 17–21 mm diam.; hypanthium dense pubescens sed interdum in apice; lobi calycis late triangulares,  $\pm$  3 mm longi, glabri adaxialiter, pubescentes abaxialiter, marginibus glandulo-denticulatis,  $\pm$  viridibus; petala suborbiculata, pallidissime crenea; stamina 10, antheris roseis; styli 3–5. Infructescentiae pauci (1–5(–6)) -fructatae. Fructus 10–12 mm alti, subglobosi vel late turbinati, subviolacei, serius atrorubri, rubroprunini et vinacei, usitate  $\pm$  pubescentes; lobi calycis 4–5 mm longi, anguste-triangulares,  $\pm$  patentes, recurvati; pyrenae 3–5, lateribus planis vel vadositer concavis, forte sulcatae dorsaliter.

Shrub, wide-branching, or small tree 2.5–4(–5) m tall; thorns 1.5–2.5(–3) cm long,  $\pm$  straight, the shorter conical and very stout, glossy very dark red-brown in second year; older dark gray; extending shoots pubescent, dark reddish-green; one year old shiny dark red-brown; two year old dark reddish and gray; older gray. Leaves deciduous; petioles 25–35% length of blade, quite slender, densely pubescent in sulcus abaxially, none to few sessile glands, or stipitate glands at leaf base; laminae half-grown at anthesis, at maturity 4–8 cm long,  $\pm$  elliptic or broad-elliptic to rhomb-elliptic in general shape, base cuneate to narrow cuneate, apex acute; lobes 2–4 / side, max. IFI (0–)5–20(–25)%, tips subacute to broadly cuspidate; margins with small crenate-serrate or serrate teeth; venation craspedodromous, 4–6 pairs of hardly impressed main lateral veins; pubescence adaxially  $\pm$  dense appressed scabrous-pubescent only, persisting, abaxially appressed scabrous-pubescent on the veins, the surfaces glabrous or with scattered hairs young. Inflorescences 4–10 flowered; branches densely pubescent bearing caducous, membranous, somewhat reddish, narrow, densely gland-margined bracteoles. Flowers 17–21 mm diam.; hypanthium densely pubescent except sometimes at the top; calyx-lobes broad triangular,  $\pm$  3 mm long, abaxially glabrous, adaxially pubescent; margins glandular-denticulate, greenish; petals suborbiculate, palest cream; stamens 10, anthers pink; styles 3–5. Infructescences few (1–5(–6))-fruited. Fruit 10–12 mm tall, subglobose to broad-turbinate, pale lake, turning



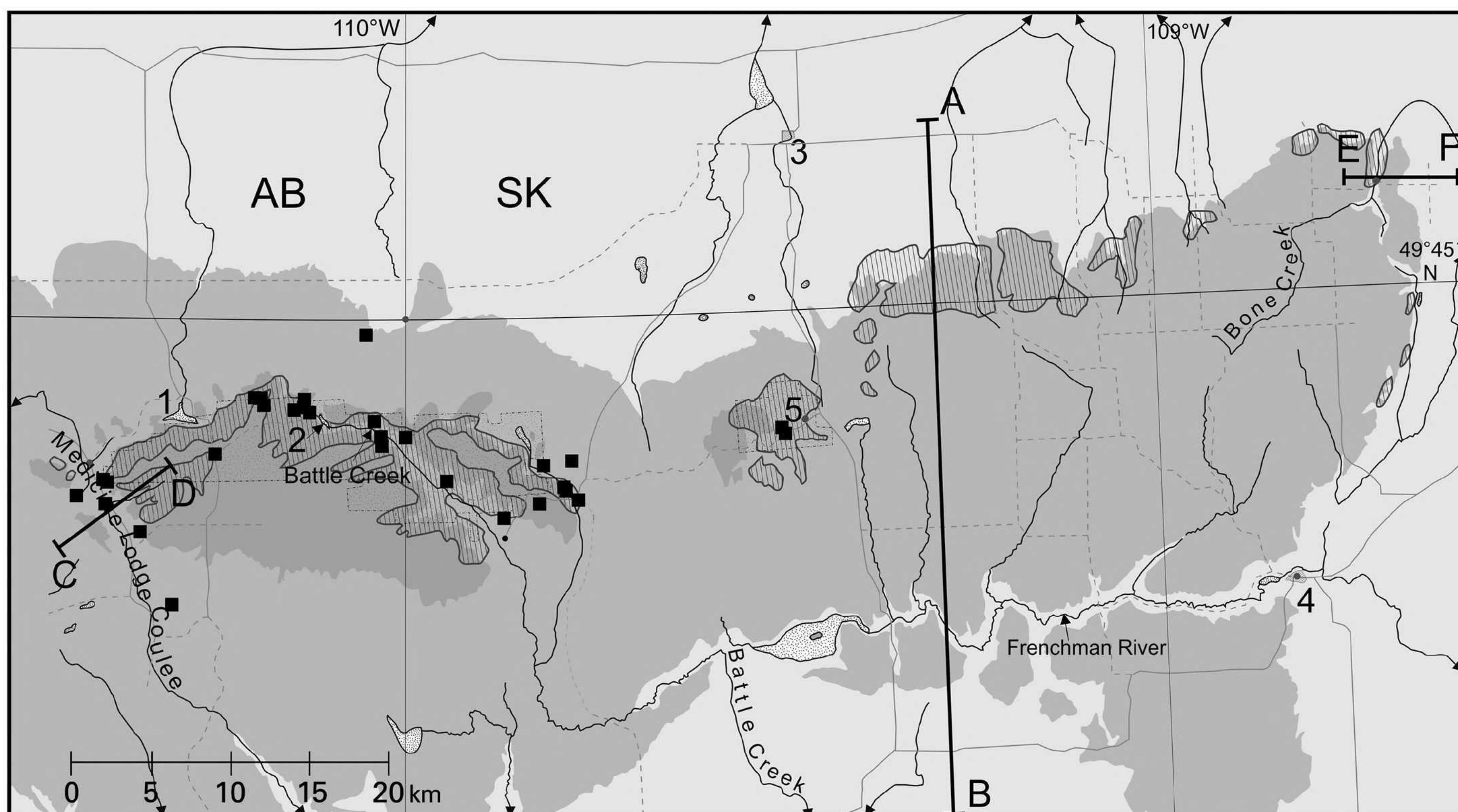


FIG. 14. Map of *C. rivuloadamensis* distribution in the Cypress Hills. Base map same as for Fig. 2.

through deep red to reddish plum and burgundy, generally rather hairy; calyx-lobes 4–5 mm long, narrow-triangular,  $\pm$  patent to recurved; nutlets 3–5, sides plane to very shallow concave, back strongly ridged.

*Common name.*—Adams Creek Hawthorn.

*Distribution (Fig. 14).*—Widespread in the upper (mainly above 1150 m) parts of the Cypress Hills with the great majority of the records found west of SK271 and SK615. Occurs in thickets, in open places and under *Populus* species. Not recorded from elsewhere.

The extremely dark young wood and short, often  $\pm$  conical thorns show a superficial resemblance to species of the Eurasian section *Sanguineae*. However, the unpitted nutlets are a marked difference. The flowers appear to be palest cream rather than pure white. *Crataegus rivuloadamensis* is named for Adams Creek along whose upper reaches it is quite plentiful and where we first recognized it as distinct.

Early collections of *C. rivuloadamensis* are by Breitung in 1947 and Moss in 1952 (see cited specimens for both). They both come from unspecified locations in the west of the Cypress Hills in Alberta. Breitung called his specimen *C. columbiana* and Moss called his *C. chrysocarpa*.

**6. *Crataegus purpurella*** J.B. Phipps & O'Kennon, sp. nov. (**Plates 6.2b, 7.2b; Fig. 15**). TYPE: CANADA. SASKATCHEWAN: Cypress Hills, Centre Block, spillway of Loch Lomond, alt. 3930 ft, 15 Sep 2003, J.B. Phipps & R. O'Kennon 8557 (HOLOTYPE: UWO; ISOTYPES: CAN, DAO, SASK, TRT).

Frutex dense ramunculiformis vel arbor parva, 2–3.4 m alta; ramuli prorecti  $\pm$  glabri, potius anthocyananei; annotini mediocriter vel atrobrunnei, aliquantum nitentes, cinerei post secundum annum; spinae frequentes, 2–3.5 cm longae, rectae vel minus curvatae, atrobrunneae annotinae. Folia decidua; petioli 30–40% longitudinis laminae, tenues, pubescentes in sulco adaxiali, ferentes 1-paucos, parvos, sessiles glandes; laminae 2.5–4.0 cm longae in anthesi, 3.5–4.5(–5) cm in maturitate,  $\pm$  late rhombeae vel late ellipticae in forma generali, 0.7–1.0 latiores quam longa in maturitate; bases cuneatae, apices acutae vel subacutae; lobi 2–3 per latus, max. IFI 15–25%; margines cum parvissimis acutis vel subacutis dentibus; venatio craspedodroma, venis (3–)4–6 per latus; adaxialiter appresso-scabro-pubescentes in juventute, saepe  $\pm$  glabrescentes; abaxialiter  $\pm$  glabrae. Inflorescentiae 6–15 floratae; ramuli subglabri vel sparsim pilosi, ferentes caducas, membranaceas, pallide brunneas, angustissimas, glandulo-marginatas bracteolas. Flores 13–16 mm diam.; hypanthium glabrum vel sparsim pilosum; lobi calyci 3 mm longi, triangulares, adaxialiter pubescentes, abaxialiter glabri, marginibus glandulo-denticulatis, usiter pallide viridibus; petala alba, circularia; stamina 10, antheris roseis; styli 3–4. Infructescentiae 1–4 fructatae; pedicelli subglobosi vel sparsim pilosi. Fructus (9–)11–12 mm alti, ellipsoidei vel subglobosi, atrorubri vel rubro-vinosi in juventute,



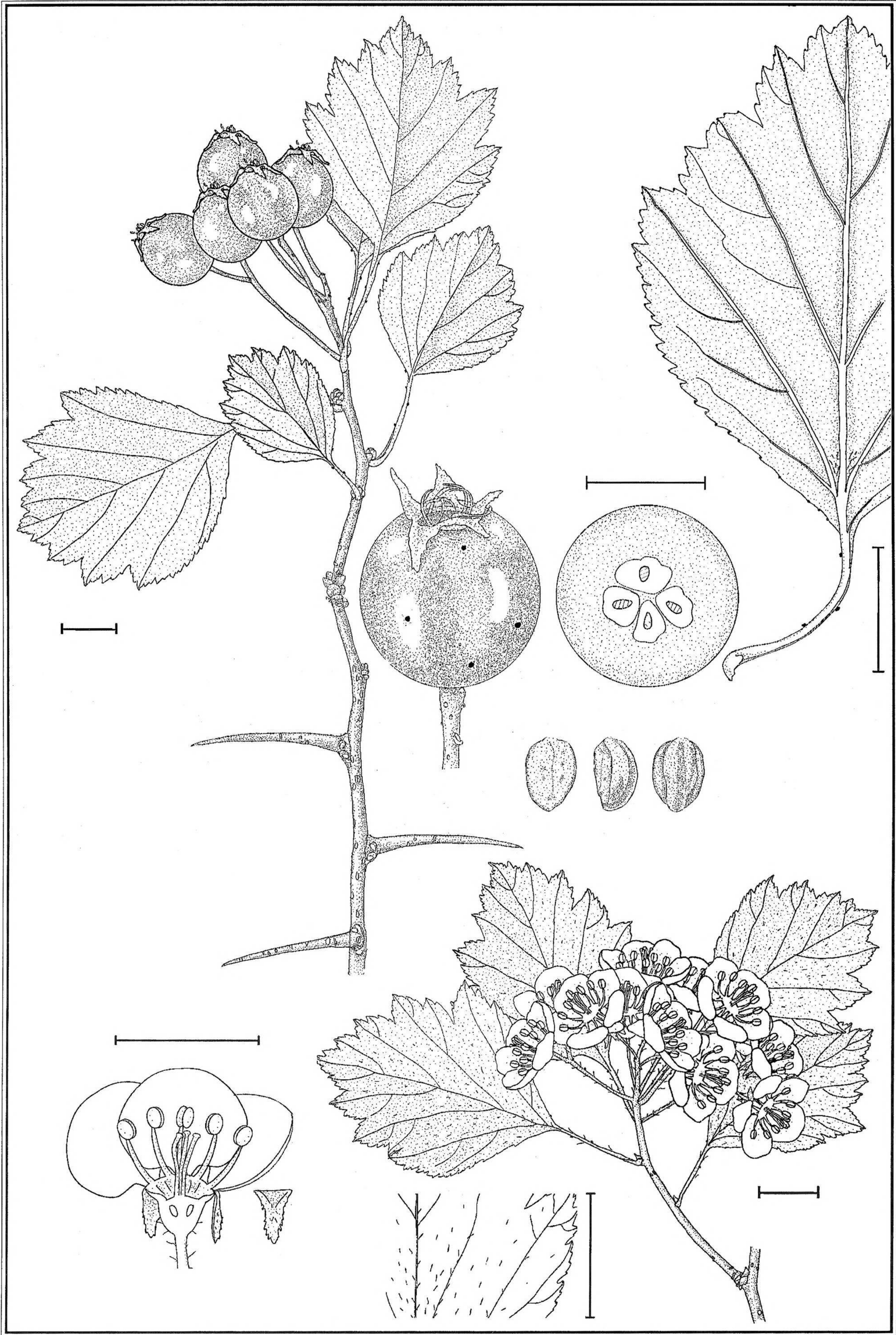


FIG. 15. Line drawing of *C. purpurella*. Specimens used: Phipps & O’Kennon 8943 (flowering); Phipps & O’Kennon 8614, 8871 (fruiting). Mags show whole leaf abaxial surface, pubescence on part young leaf adaxial surface, flower section and calyx-lobe, fruit and nutlets. S. Laurie-Bourque del.; scale bars equal 1 cm.



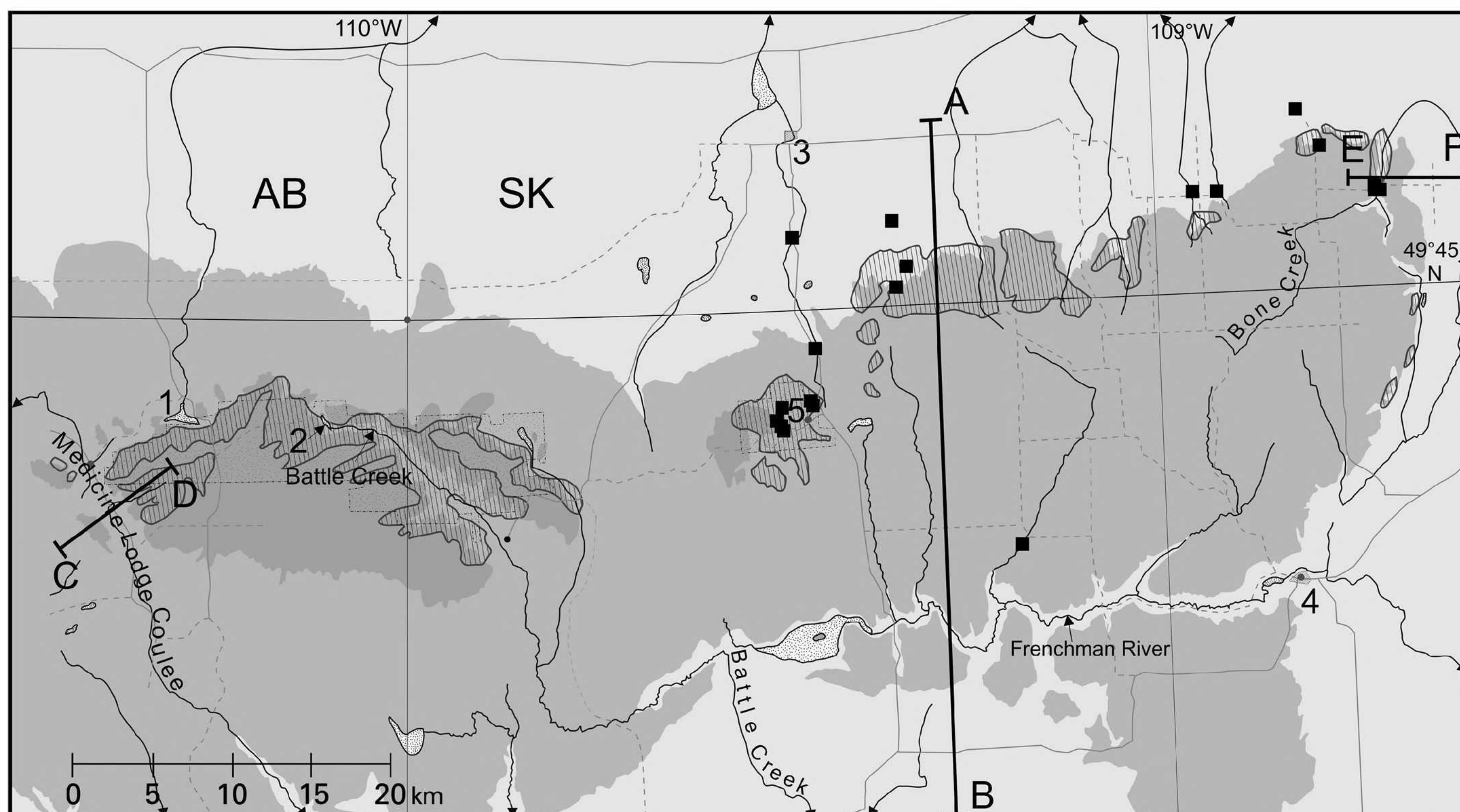


FIG. 16. Map of *C. purpurella* distribution in the Cypress Hills. Base map same as for Fig. 2.

atropurpureae in maturitate; lobi calycis 4–4.5 mm longi, acuti, erosi vel patentes; pyrenae 3–4, lateribus sulcatis longitudinaliter vel vadositer concavis, dorsaliter vadositer ± profunde sulcatae.

Dense twiggy bush or small tree 2–3.5 m tall; extending twigs ± glabrous, rather anthocyanic; at 1 year medium to deep, somewhat glossy brown; two year old twigs gray; thorns 2–3.5 cm long, rather frequent, straight to slightly curved, slender to somewhat stouter, deep brown at one year, nearly black at two years. Leaves deciduous; petioles 30–40% of length of blade, slender, pubescent in adaxial sulcus, bearing 1–few small sessile glands; blades 2.5–4.0 cm long at anthesis, 3.5–4.5(–5) cm at maturity, ± broad rhombic to broad elliptic in general shape, 0.7–1.0 × as broad as long at maturity; base cuneate, apex acute to subacute; lobes 2–3/side, max. LII 15–25%; margins with very small subacute to acute teeth; venation craspedodromous, (3–)4–6 per side; appressed scabrous-pubescent adaxially young, often ± glabrescent later, ± glabrous abaxially. Inflorescences 6–15 flowered; branches subglabrous to thinly pilose, bearing caducous, membranous, pale brown, very narrow, gland-margined bracteoles. Flowers 13–16 mm diam.; hypanthium glabrous to sparsely pilose; calyx-lobes 3 mm long, triangular, adaxial surface pubescent, abaxial surface glabrous, margins glandular-denticulate, generally pale green; petals white, circular; stamens 10, anthers pink; styles 3–4. Infructescence with 1–4 fruit, pedicels subglabrous to thinly pilose. Fruit (9–)11–12 mm tall, ellipsoid to subspherical, deep red to red-burgundy younger, deep purple fully ripe; calyx-lobes 4–4.5 mm long, pointed, spreading or eroded; nutlets 3–4, longitudinally grooved or very shallowly concave, shallowly or more deeply furrowed dorsally.

*Common name.*—Loch Lomond Hawthorn.

*Distribution (Fig. 16).*—*C. purpurella* is a species widespread in the eastern half of the Cypress Hills with an eastern limit near the provincial park headquarters in Saskatchewan and is not known elsewhere. It is common in thickets along north slope draws.

The most similar species is *C. rivulopugnensis*, with which *C. purpurella* is allopatric. Both are slender, delicate bushes in the shade of aspen but much denser in the open and both have shortish slender thorns. *Crataegus purpurella* differs from *C. rivulopugnensis* in generally much smaller, fewer-veined leaves and greater thorn curvature (Figs. 5b.4, 5a.2) as well as in the deep purple, rather than red, fruit at maturity. The name



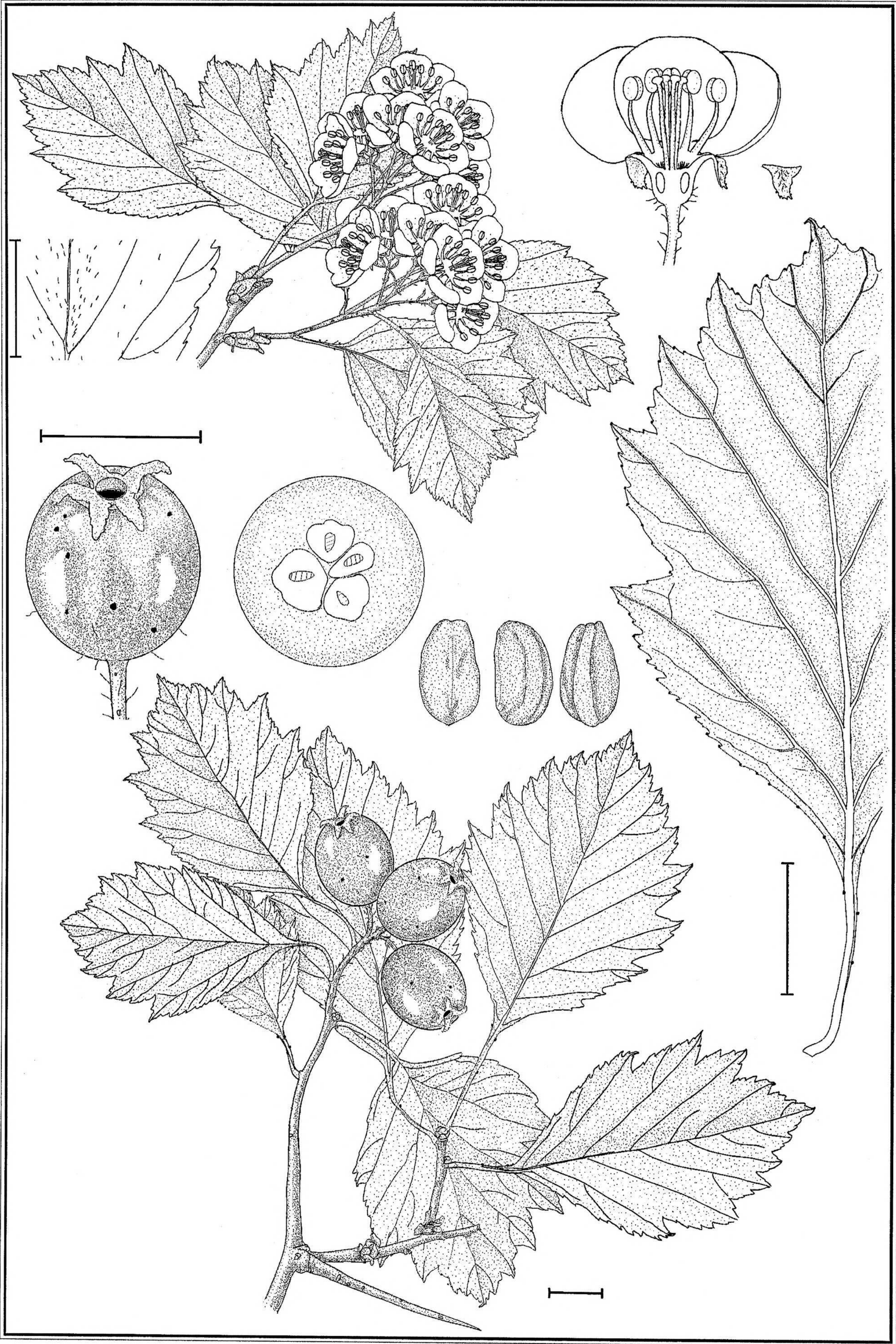


FIG. 17. Line drawing of *C. rivulopugnensis*. Specimens used: Phipps & O’Kennon 8996 (flowering); Phipps & O’Kennon 8795 (fruiting). Mags show whole leaf abaxial surface, pubescence on part young leaf adaxial surface, flower section and calyx-lobe, fruit and nutlets. S. Laurie-Bourque del.; scale bars equal 1 cm.



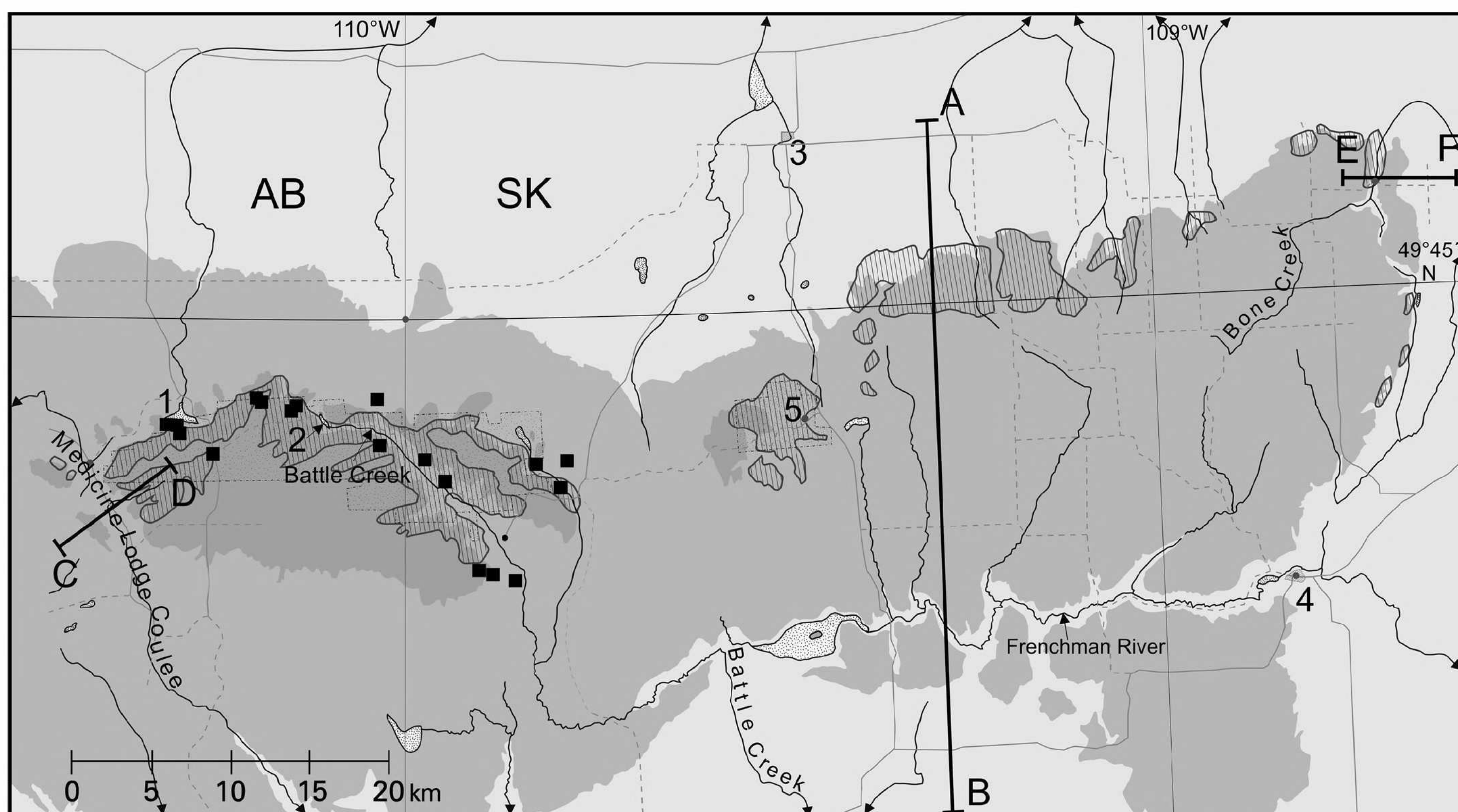


FIG. 18. Map of *C. rivulopugnensis* distribution in the Cypress Hills. Base map same as for Fig. 2.

refers to the deep purple fruit fully ripe, the small leaves and the delicacy of the species in the usual form in which it is seen.

**7. *Crataegus rivulopugnensis*** J.B. Phipps & O'Kennon, sp. nov. (**Plates 5c, 7.2d; Fig. 17**). TYPE: CANADA. SASKATCHEWAN: Cypress Hills, Reno Rur. Mun., high draws above Shafer Creek, alt. 1258 m, 13 Sep 2003, J.B. Phipps & R. O'Kennon 8533 (HOLOTYPE: UWO; ISOTYPES DAO, CAN, SASK, ALTA, TRT).

Frutex vel arbor parva, 2–5 m alta, gracilis nisi in loco aprico; ramuli prorecti primum sparsim pubescentes, glabrescentes; annotini atrorubento-vel atropurpureo-brunnei; mediocriter brunnei post secundum annum, veteriores atrocinerei; spinae frequentiores vel frequentissimae, 2.5–4 cm longae, rectae vel recurvatae, tenues; nitentissimae atrorubro-brunneae post secundum annum. Folia decidua; petioli 25–30% longi quam laminae, pubescentes solo in sulco adaxiali, cum paucis vel pluribus glandis sessilibus; laminae 4–6 cm longae in maturitate, aliquantulum minus in anthesi pleno, late ellipticae vel ovatae in forma generali; basis cuneata vel late cuneata vel curvata; apex acutus; lobi 3–4 per latus, max. IFI 15–25%; margines cum numerosis parvis acutis vel acuminatis dentibus; venatio craspedodroma, venis lateralibus principalibus 5–8 per latus, leviter impressis; pubescentia adaxialiter moderate vel sparsim pubescentes in maturitate; abaxialiter perfecte glabrae in juventute praeter interdum parvos caespes pilorum axillares. Inflorescentiae 5–15 floratae; ramuli moderate vel sparsim pilosi, ferentes sparsim, etiam in juventute, caducas, angustissimas, pallide brunneas, glandulo-marginatas bracteolas. Flores (solo paucae plantae visae in anthesi), ca. 16 mm diam.; hypanthium glabrum vel ± pilosum ad basem; lobi calycis ca. 4 mm longi, triangulares, virides cum marginibus pallidis, marginibus glandulo-denticulatis, adaxialiter sparsim pilosi, abaxialiter glabri; petala ± circularia, alba; stamina ca. 10, antheris pallide roseis vel roseis; styli 4 in floribus visi. Infructescentiae 1–4 fructatae; ramuli glabri vel moderate pubescentes; fructus 8–10(–12) mm alti, ellipsoidei vel suborbiculares, rubri primo, claro rubri vel atrorubri in maturitate plena, glabri vel sparsim pubescentes; lobi calycis triangulares, glandulo-serrati, patento-reflexi vel recurvati; pyrenae 3–5, dorsaliter sulcatae, facibus lateralibus ± planis vel vadositer et levigater concavis, concavitatibus profundissimis in pyrenis angustissimis.

Bush or small tree 2–5 m tall, slender unless in full sun, extending twigs thin-pubescent at first, glabrescent; one-year old twigs deep reddish- or deep purple-brown; two-year old twigs mid-brown, older deep gray; thorns moderately to very frequent, 2.5–4 cm long, straight to recurved, slender, bright shining dark red-brown at two years. Leaves deciduous; petioles 25–30% of length of blade, pubescent only in the adaxial sulcus, with few to several small sessile glands; blades 4–6 cm long at maturity, a little less at full anthesis, broad elliptic to ovate in general shape; base cuneate to broad cuneate or rounded; apex acute; lobes 3–4/side, max. LII 15–25%; margins with numerous small acute to acuminate teeth; venation craspedodromous, main



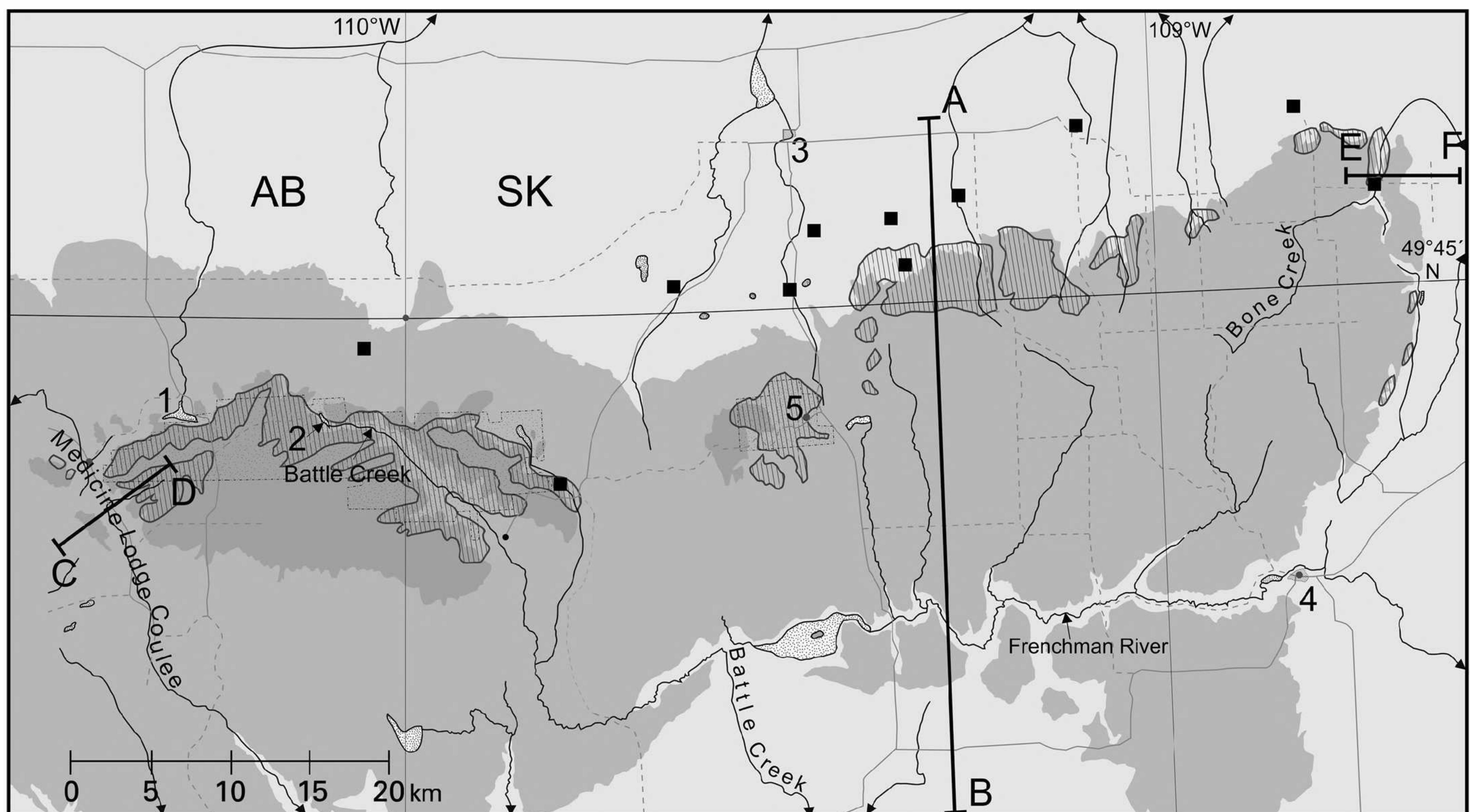


FIG. 19. Map of *C. macracantha* distribution in the Cypress Hills. Base map same as for Fig. 2.

lateral veins 5–8 pairs, slightly impressed; pubescence adaxially thinly to moderately densely scabrous-hairy young, subglabrous to thinly scabrous pubescent at maturity, abaxially completely glabrous young except for sometimes small axillary tufts of hair. Inflorescence 5–15 flowered; branches very thinly to moderately pilose, bearing sparse, even when young, caducous, very narrow, membranous, light brown, gland-margined bracteoles. Flowers (only few plants seen at full anthesis) ca. 16 mm diam.; hypanthium glabrous to somewhat pilose towards the base; calyx-lobes ca. 4 mm long, triangular, margins glandular-denticulate, adaxially sparsely pilose, abaxially glabrous, green with pale edges; petals  $\pm$  circular, white; stamens ca. 10, anthers pale pink to pink; styles 4 in flowers seen. Infructescence 1–4 fruited; branches glabrous to moderately pubescent; fruit 8–10(–12) mm tall, ellipsoid to suborbicular, red early, bright to deep red fully ripe, glabrous to thin pubescent; calyx-lobes triangular, glandular-serrate, spreading–reflexed to recurved; nutlets 3–5, dorsally furrowed, sides  $\pm$  plane to shallowly and smoothly concave, the concavity deepest on narrowest nutlets.

*Common name.*—Battle Creek Hawthorn.

*Distribution (Fig. 18).*—*Crataegus rivulopugnensis* has a wide distribution in the western part of the Cypress Hills from Adams Creek westwards. It is not known elsewhere. There appear to be no earlier collections than our own.

Although the color of the ripe fruit is quite different (red vs. deep purple), *C. rivulopugnensis* is in other respects similar to *C. purpurella*, differing most obviously in its almost exactly allopatric distribution, generally greater leaf size and number of lateral veins per side (5–8 vs. 4–6). Both these species have less hairy adaxial leaf surfaces than most other Cypress Hills hawthorns, indeed they may be adaxially subglabrous at maturity.

series **Macracanthae** (Loudon) Rehder. TYPE SPECIES: *Crataegus macracantha* Lodd. ex Loudon.

Shrubs, sometimes large, seldom tree-like; thorns stout, of medium (3–5 cm) to great (occ. 11.5 cm) length. Petioles eglandular. Generally very hairy in the inflorescence; anthers pink or white; calyx-lobes with gland-tipped very short to long teeth. Fruit orange-red or red when ripe, nutlets deeply pitted laterally.



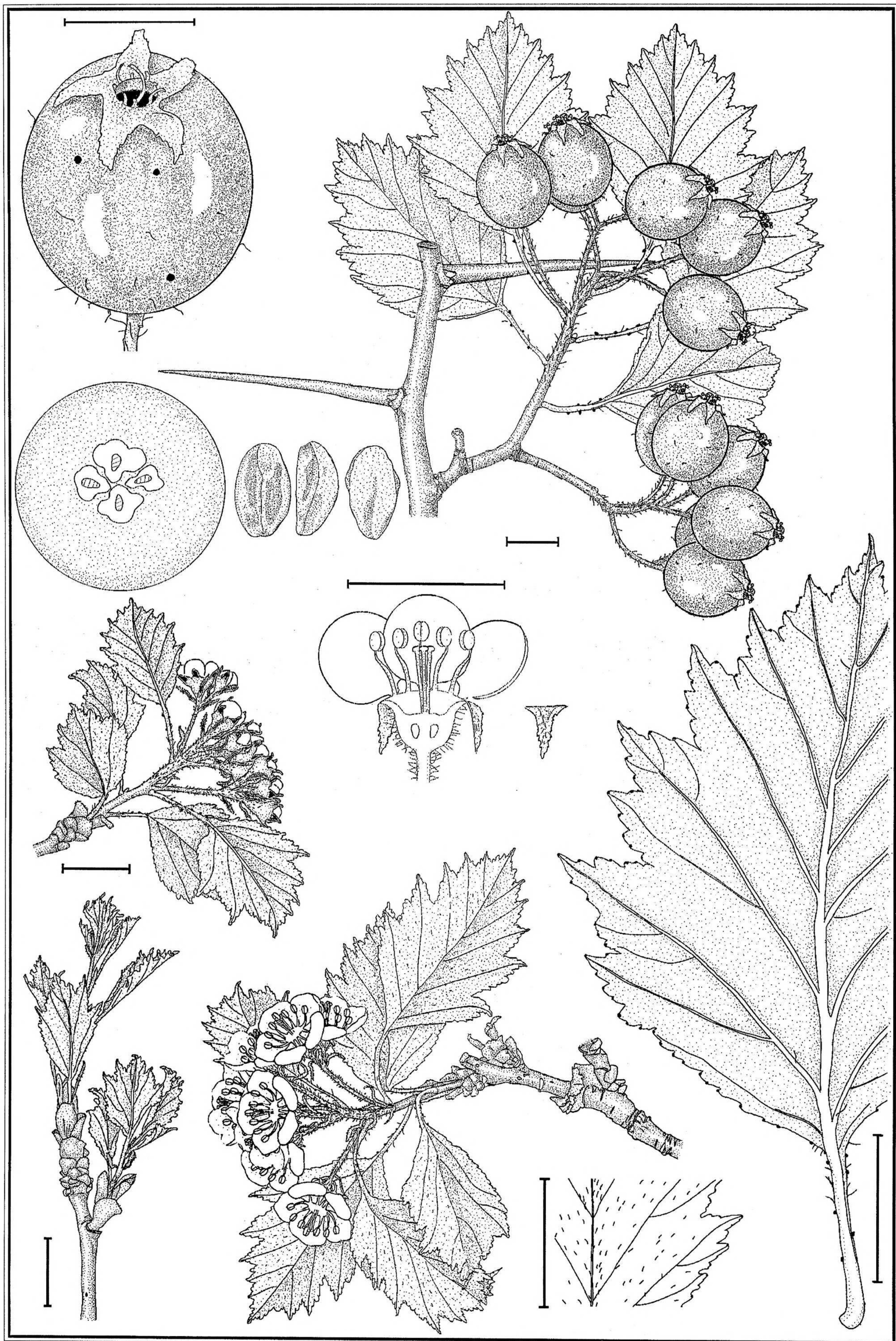


FIG. 20. Line drawing of *C. rubibracteolata*. Specimens used: Phipps & O'Kennon 8650, 8656 (flowering); Phipps & O'Kennon 8819, 8823 (fruiting). Mags show emerging leaves with enlarging bud-scales, young inflorescence with rusty red bracteoles, whole leaf abaxial surface, pubescence on part young leaf adaxial surface, flower section and calyx-lobe, fruit and nutlets. S. Laurie- Bourque del.; scale bars equal 1 cm.



Three species as normally understood, widespread in the United States and southern Canada to which *C. rubribracteolata* and *C. sheridana* are provisionally added. Both the latter have red fruit and pitted nutlets but the former has highly glandular petioles and the latter also has glandular petioles but not very stout thorns. Neither of these characters fits the traditional concept of the series. Both of these additional species also have quite strong superficial resemblances to *C. chrysocarpa*.

**8. *Crataegus macracantha*** Lodd. ex Loudon, Arbor. Frutic. Brit. 2:819. 1838. (**Plate 7.3b**). *Crataegus macracantha* Lodd., nomen nudum, in Cat. Pl. 41, 1830, per *macrocantha*.

*Crataegus succulenta* Schrad. ex Link, Handb. Erkennt. Gewächse 2:78. 1831 (in part).

*Crataegus occidentalis* Britton, Bull. New York Bot. Gard. 1:448. 1900.

A recent line drawing of this species may be found in Phipps (1997).

Differentiating characters per key and it is one of the most easily identified species of the Cypress Hills with its eroded nutlets and eglandular petioles. *Crataegus macracantha* is the 10-stamen counterpart of *C. succulenta* which species is entirely eastern. In western North America west of the Rocky Mountains *C. macracantha* is almost always white-anthered but in the Cypress Hills it is always pink-anthered.

*Common name*.—Succulent Hawthorn, in part.

*Distribution (Fig. 19)*.—*Crataegus macracantha* is a fairly common hawthorn in the Saskatchewan part of the Cypress Hills although mainly restricted to the lower altitudes and more xeric habitats, like *C. chrysocarpa*. It had been reported for that province, but not specifically from the Cypress Hills, by Harms (2003) under *C. succulenta*, but it is not in Breitung's (1954) list nor seen among his collections.

*Crataegus macracantha* may flower later, or much later, than sympatric *C. chrysocarpa* and is also characterized by bright coral-red expanding bud-scales (Plate 6.1a) when *C. chrysocarpa* is already leafed out as well as by eglandular petioles and laterally pitted nutlets. This species generally has very stout, recurved thorns and extremely dark one year old twigs and thorns.

**9. *Crataegus rubribracteolata*** J.B. Phipps & O'Kennon, sp. nov. (**Plate 6.1c, 7.3c; Fig. 20**). TYPE: CANADA.

SASKATCHEWAN: Cypress Hills, Maple Creek Rur. Mun., roadside off SK 724 near Downie Lake, alt. 860 m, 17 Sep 2004, J.B. Phipps & R. O'Kennon 8819 (HOLOTYPE: UWO; ISOTYPES: CAN, DAO, SASK).

Frutex erectus, multiramosus in aperto, late-ramosus in umbra, 2–3 m altus; squamae gemmarum expansae clare ruforubrae; ramunculi prorecti appresso-pubescentes; annotini mediocriter brunnei; post secundum annum rubro-brunnei, veteriores cinerei vel atrocinerei; spinae plerumque numerosae, 3.5–5.5 cm longae, generaliter plenae, rectae vel leviter curvatae; ± validae; post secundum annum peratro-brunneae. Folia decidua; petioli plerumque 30–35% longitudinis laminae, dense pubescentes in sulco adaxiali, ferentes multas glandes sessiles in aperto, pauciores in umbra; laminae 2.5–3.5 cm longae in anthesi, in maturitate 4–5 cm longae in aperto, 5–7 cm in umbra, ± ovatae vel ovato-trullatae; basis cuneata vel late cuneata; apex acutus vel acuminatus; lobi 5–6 per latus, acuti vel acuminati, max. IFI 25–35%; margines cum parvis, regularibus, acutis dentibus, saepe subacutis in maturitate; venatio craspedodroma, venis lateralibus (5–)6–7 per latus; pubescentia adaxialis ± dense scabro-appressa in anthesi, varie persistens ad maturitatem; pubescentia abaxialis glabra praeter sparsissimos pilos secundum mediam venam proximaliter. Inflorescentiae (6–)8–12 floratae; ramunculi ± tomentosi, ferentes abundantes, caducas, angustas, membranaceas peraurantiaco-rubras (vel decolores) dense glandulo-marginatas bracteolas. Flores 12–15 mm diam.; hypanthium ± tomentosum vel dense pubescens; lobi calycis 3–5 mm longi, triangulares, marginibus glandulo-denticulatis, pubescentes adaxialiter, glabri abaxialiter, subvirides vel pallidi, apice aliquantulum rubente vel pallidiore; petala circularia, alba; stamina ca. 10, antheris eburneis vel cremeis; styli 3–4. Infructescentiae plerumque 3–10 fructatae; pedicelli dense vel densissime pubescentes. Fructus 9–13 mm alti, plerumque in fasciculis compactis, ± ellipsoidei vel subglobosi, rubri in juventute, clare rubri in plena maturitate nisi aurantiaco-rubri in umbra, sparsim vel frequentius, ± dense pubescentes; lobi calycis plerumque appressi, 3–5 mm longi; pyrenae 3–4(–5)cm. altae, ± profunde concavae lateraliter, dorsaliter sulcatae.

Erect multistemmed bush in open, wide branching in shade, 2–3 m tall; expanding bud-scales bright rufous-red; extending twigs appressed pubescent; at one year mid-brown; at 2 yrs dark red-brown, older gray or dark gray; thorns generally plentiful, usually 3.5–5.5 cm long, straight to slightly curved, ± stout, at two years dark blackish-brown. Leaves deciduous; petiole usually 30–35% length of blade, densely pubescent in the adaxial sulcus, bearing numerous sessile glands in the open, fewer in shade; blades ± ovate to ovate-trullate, 2.5–3.5 cm long at anthesis, at maturity 4–5 cm long in open, 5–7 cm in shade; base cuneate to broad cuneate; tip acute to acuminate; lobes (4–)5–6 per side, acute to acuminate, max. LII 25–33%; margins with



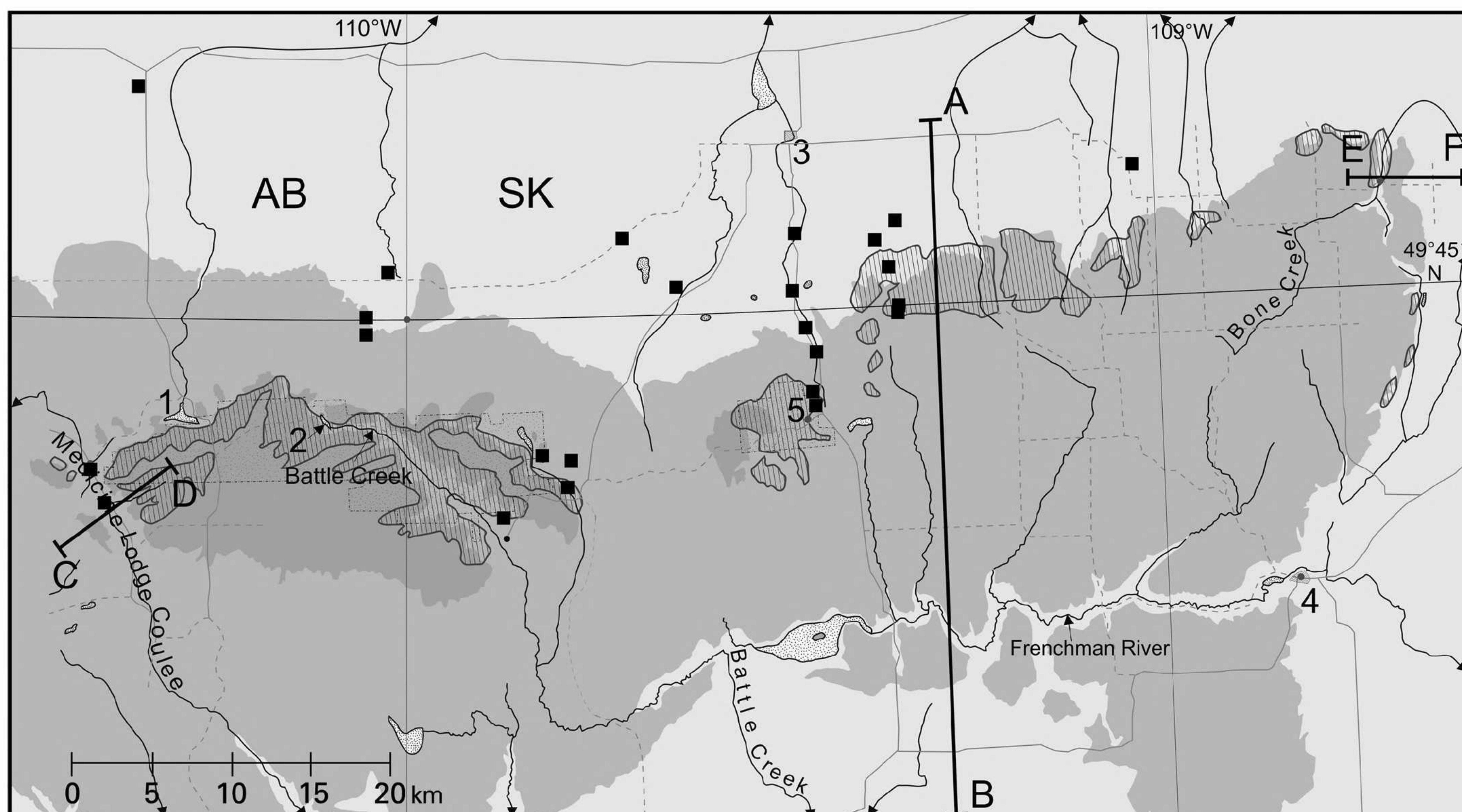


FIG. 21. Map of *C. rubribracteolata* distribution in the Cypress Hills. Base map same as for Fig. 2.

small, regular, acute teeth often subacute at maturity; venation craspedodromous, lateral veins (5–)6–7 per side; adaxial pubescence  $\pm$  dense scabrous-appressed at anthesis, variably persistent to maturity, abaxially glabrous except for sparse hairs along the mid-vein proximally. Inflorescences mainly (6–)8–12 flowered; branches  $\pm$  tomentose, bearing abundant, caducous, narrow, membranous, deep orange-red or fading, densely gland-margined bracteoles. Flowers 12–15 mm diam.; hypanthium  $\pm$  tomentose or densely pubescent; calyx-lobes 3–5 mm long, triangular, margins glandular-denticulate, pubescent adaxially, glabrous abaxially, greenish or pale, the tip somewhat reddish or paler; petals circular, white; stamens ca. 10, anthers ivory or cream; styles 3–4. Infructescences usually 3–10 fruited; branches densely or very densely pubescent. Fruit 9–13 mm tall, generally in  $\pm$  compact clusters,  $\pm$  ellipsoid to subglobose, red early, bright red fully ripe or more orange-scarlet in shade, sparsely, or more usually fairly densely pubescent; calyx-lobes usually appressed, 3–5 mm long; nutlets 3–4(–5),  $\pm$  deeply concave laterally, dorsally furrowed.

*Common name.*—Red Bracteole Hawthorn.

*Distribution (Fig. 21).*—*Crataegus rubribracteolata* is common to abundant throughout the Cypress Hills in suitable habitats. We have one record from Montana, Hill Co., Bear's Paw Mountains. *Crataegus rubribracteolata* was first collected by S.E. Clarke in 1937 at Piapot, Saskatchewan. We have so far noted no other collections of this species besides our own.

The characteristic upright habit of this species when grown in full light helps recognition. It is very similar in leaf shape, inflorescence and indumentum to *C. ursopedensis*, though the mature leaves average smaller except in shade forms and the inflorescence indumentum is denser. The much shorter leaves of high-light thicket situations (Fig. 5b.2) readily contrast with those of *C. ursopedensis* but in more shaded habitats the larger leaf dimensions of *C. rubribracteolata* are similar to *C. ursopedensis*. It is thus often quite easy to confuse with that species unless technical characteristics are carefully considered. The flowers are smaller and in more compact inflorescences and the bracteoles and bud scales strikingly orange-red in *C. rubribracteolata* (particularly striking in the young inflorescences, Fig. 6.1c), whereas the bracteoles of *C. ursopedensis* are pallid or only lightly tinged with green or pale red, especially towards the tips and much more heavily gland-margined (Fig 6.1d). Intense reddish tints may also be seen as the tips of calyx-lobes in



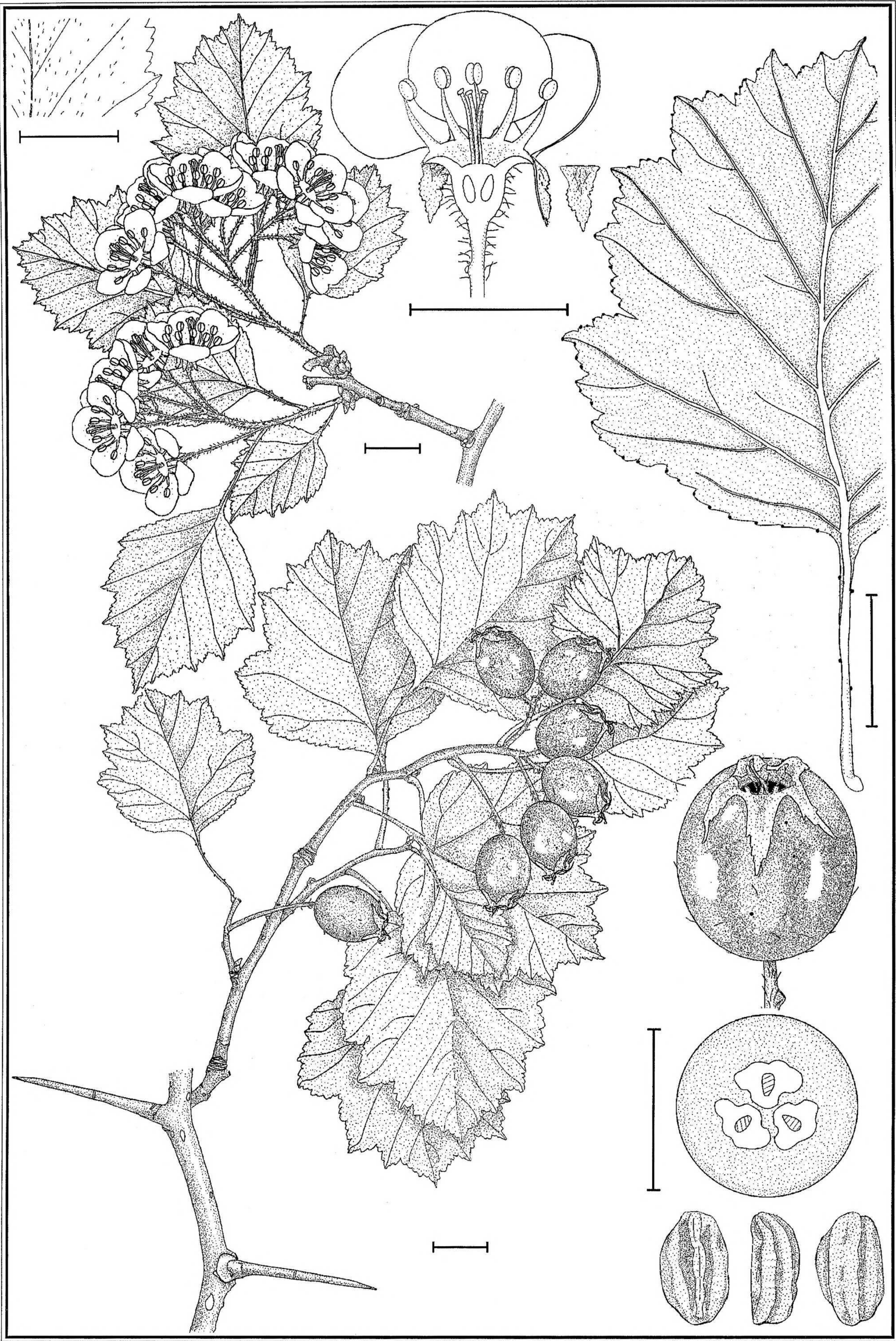


FIG. 22. Line drawing of *C. sheridana*. Specimens used: Phipps & O’Kennon 8936 (flowering); Phipps & O’Kennon 8880 (fruiting). Mags show whole leaf abaxial surface, pubescence on part young leaf adaxial surface, flower section and calyx-lobe, fruit and nutlets. S. Laurie-Bourque del.; scale bars equal 1 cm.



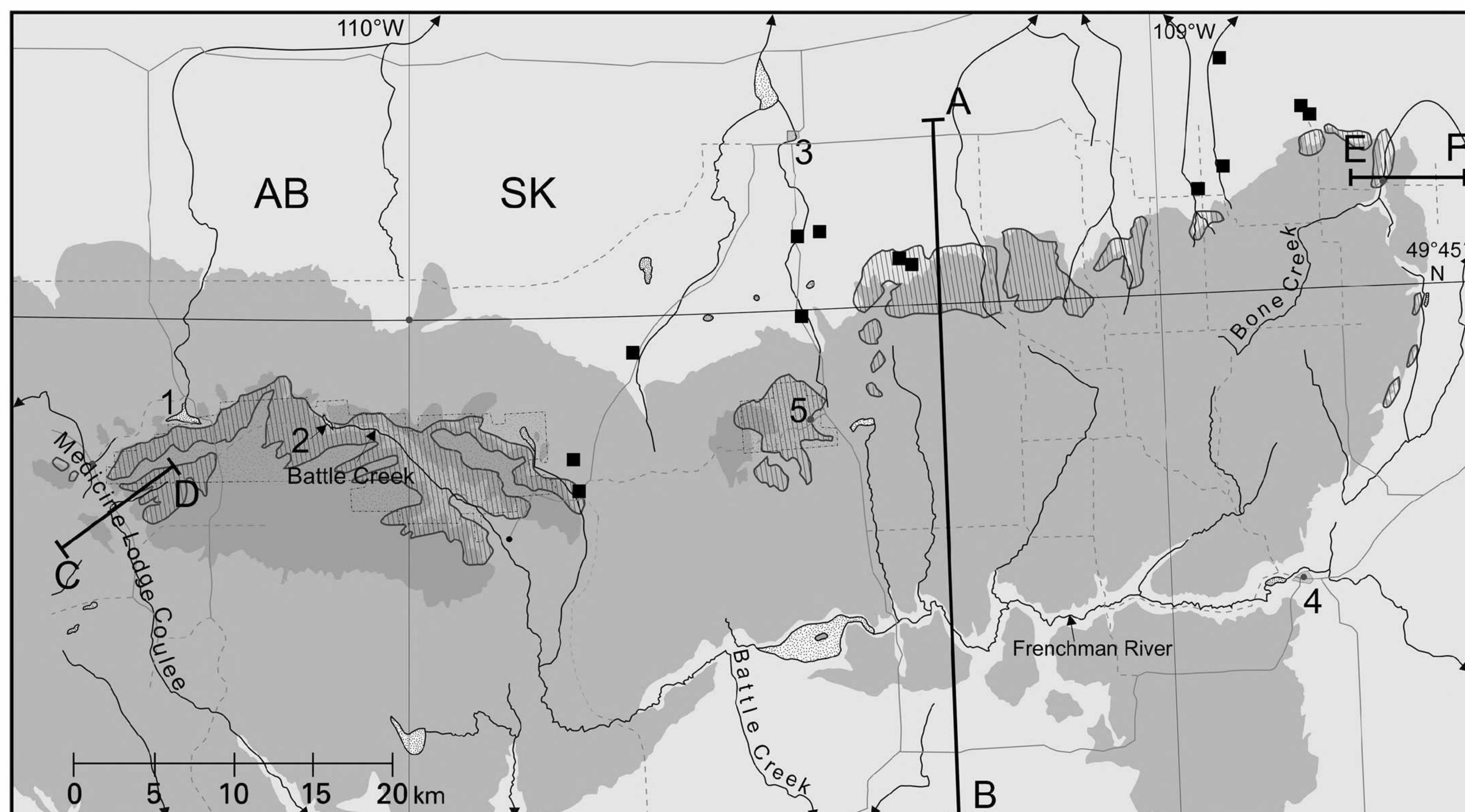


FIG. 23. Map of *C. sheridana* distribution in the Cypress Hills. Base map same as for Fig. 2.

young flowers of *C. rubibracteolata*. In fruit the shortish calyx-lobes are practically always tightly appressed and the nutlets have a well defined lateral concavity. The species is named for the reddish bracteoles.

This species and *C. cupressocollina* are the two earliest Cypress Hills hawthorns to flower.

**10. *Crataegus sheridana*** A. Nels., Contr. Rocky Mtn. Herb. 4:370. 1902. (**Plate 7.3d; Fig. 22**). TYPE: U.S.A. WYOMING: Sheridan, 25 Jul 1901, A. Nelson 8673 (LECTOTYPE designated here: RM!). US also has a specimen with this label data except for a date of 24 July.

Bush 2–3.5 cm tall; extending shoots pubescent, at one year light brown to olive-tan or mid-brown, at two years dark gray or reddish brown overlaid dark gray, older gray; thorns  $\pm$  frequent (2.5–)3–5(–7) cm long, usually recurved, slender to moderately thick, at two years very dark shiny red-brown. Leaves deciduous; petioles 40–50 % length of blade,  $\pm$  pubescent, especially in the adaxial sulcus, bearing several to many small sessile glands; blades 3.5–5(–6) cm long at maturity, nearly full grown at anthesis, at least some usually broad ovate or suborbicular in general shape, remainder usually  $\pm$  ovate; base cuneate, broad-cuneate or  $\pm$  truncate to subcordate on wider leaves; tip acute; lobes (3–)4(–5) per side, acute and shallow, max. LII 10–20(–25) %; margins with small, subacute teeth; adaxial surface densely appressed scabrous-pubescent young, variably persistent; abaxially with glabrous surface, veins glabrous to  $\pm$  pubescent, this barely persisting. Inflorescences 5–15 flowered; branches  $\pm$  densely pubescent, bearing caducous, membranous, pallid, narrow, gland-bordered bracteoles. Flowers 14–16 mm diam.; hypanthium  $\pm$  tomentose below, dense short-pubescent higher; calyx-lobes triangular,  $\pm$  pubescent adaxially, glabrous abaxially, greenish, the margins glandular-serrate; petals  $\pm$  circular, white; stamens ca. 10, anthers ivory; styles usually 4–5. Infructescences 1–6 fruited, branches usually densely pubescent. Fruit 9–11 mm tall, usually broadly ellipsoid to suborbicular, bright red,  $\pm$  pubescent (? very rarely subglabrous), calyx-lobes  $\pm$  spreading to reflexed; nutlets usually 3 or 4, sides  $\pm$  roughened with shallow irregular pitting or diagonal scarring, dorsally  $\pm$  deeply furrowed.

*Common name*.—Great Plains Hawthorn.

*Distribution* (**Fig. 23**).—*Crataegus sheridana* is a quite abundant hawthorn in the Cypress Hills and nearly all our records are found in the high light thicket situations, rather than aspen. UWO also has definite records



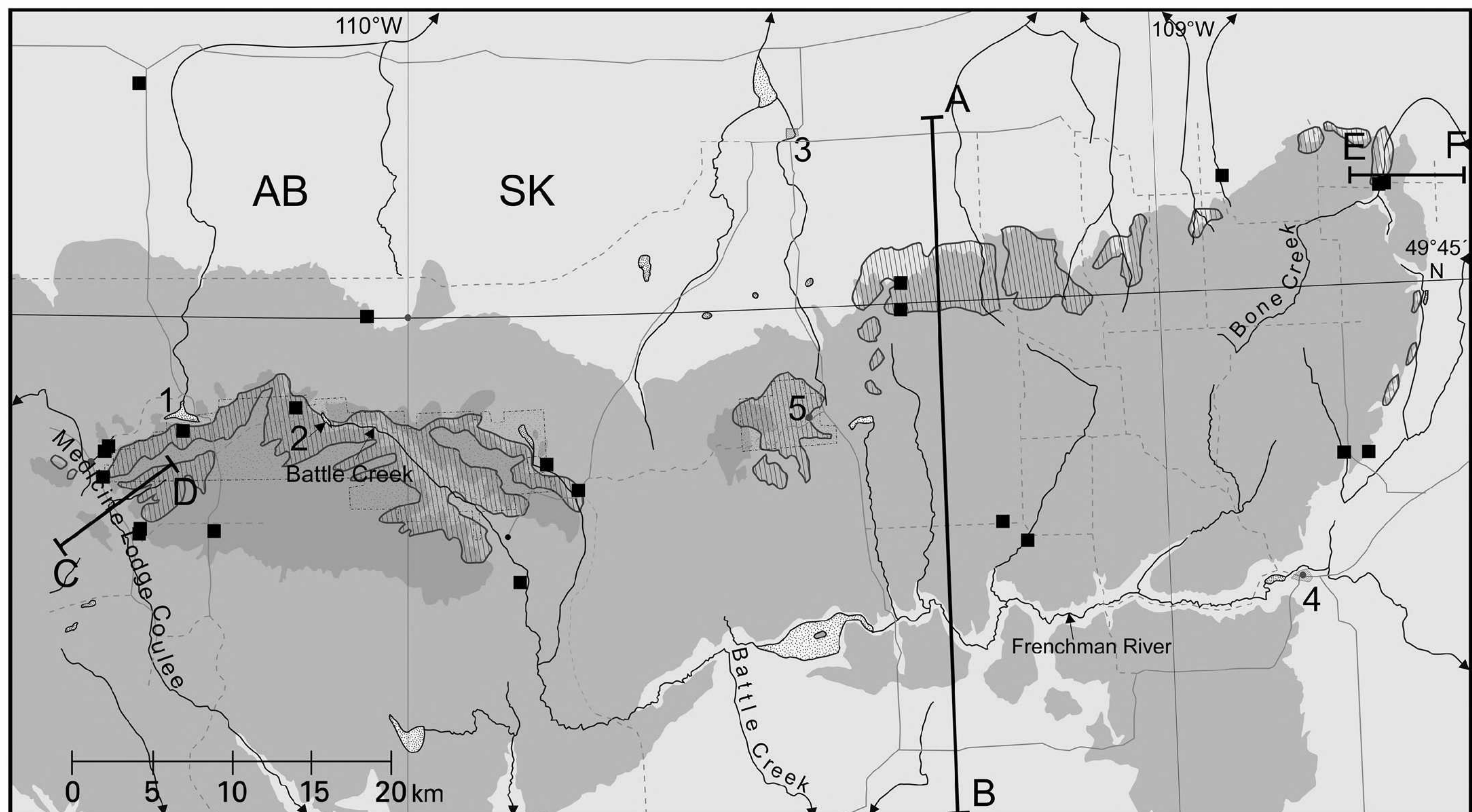


FIG. 24. Map of *C. chrysocarpa* distribution in the Cypress Hills. Base map same as for Fig. 2.

from Saskatchewan, Montana, North and South Dakota, Wyoming and west-central Minnesota. There are also other records from Saskatchewan in prairie regions away from the Cypress Hills, such as Swift Current. Until confusion with the *C. chrysocarpa* complex of the Great Plains and Prairies is fully cleared up we will only have an incomplete knowledge of its distribution, but it does seem to be widespread in this region.

*Crataegus sheridana* has strong superficial resemblances to the *chrysocarpa* group but is distinguished by its laterally pitted nutlets. It tends to have shorter thorns than other hawthorns in the red-fruited, eroded-nutlet group and is also distinguished from most specimens in the Cypress Hills *chrysocarpa* group by its particularly densely pubescent to tomentose inflorescence branches and hypanthium. In addition, once known, the characteristic leaf shape makes it very recognizable. Nelson caused some confusion in citing as a cotype his specimen 1204 (RM), which is a perfectly typical specimen of *C. macracantha*. Unfortunately, the holotype, which was obviously quite different from the cotype, and whose fruit I did not dissect for Phipps (1998), does possess the superficial resemblance to *C. chrysocarpa* mentioned above and I therefore wrongly synonymized it with *C. chrysocarpa* in that paper as E.P. Kruschke and W.W. Eggleston both did on their annotation labels.

series **Rotundifoliae** (Eggl.) Rehder, Sect. *Rotundifoliae* Eggl. TYPE SPECIES: *Crataegus rotundifolia* Moench.

Here treated as restricted to *C. chrysocarpa* and immediate relatives. Shrubs, seldom large; petioles glandular; leaf-blades somewhat small; flowers of medium size; anthers pink or white; ripe fruit red; nutlets smooth laterally.

Two species, in the restricted sense of the series, both found in the Cypress Hills. Western Canadian taxa were reviewed in Phipps and O'Kennon (2004).

*Crataegus ursopedensis* may not belong but is provisionally placed here. It has much larger leaves (5.5–9.5 cm long), generally longer thorns (4–7 cm) and the lateral faces of nutlets may be somewhat concave.

**11. *Crataegus chrysocarpa*** Ashe, Bull. North Carolina Exp. Sta. 175:110. 1900. (Plate 7.4a,b; Fig. 8, lower).

*Crataegus rotundifolia* Moench, in part, sens. auctt. Amer.



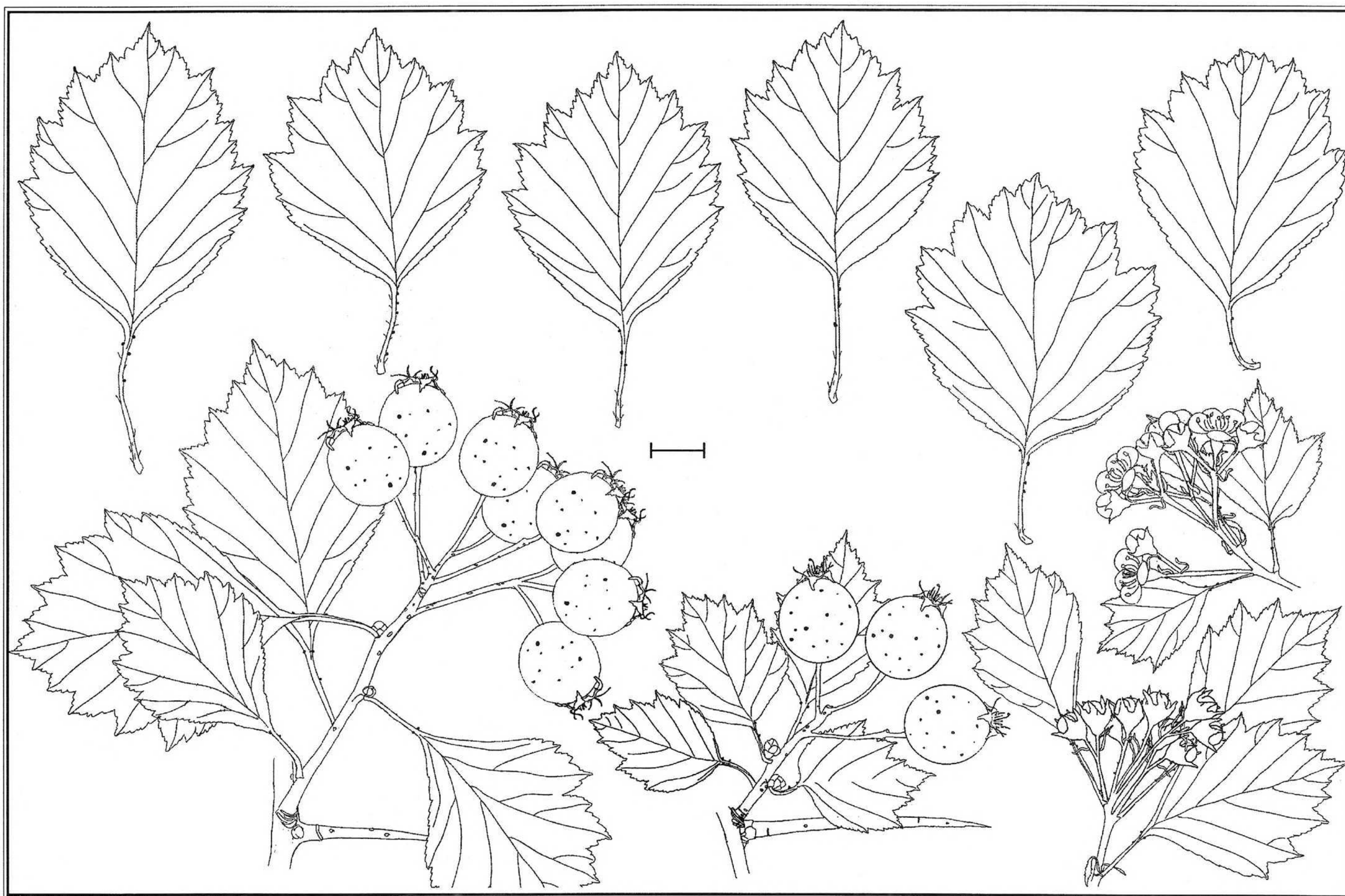


FIG. 25. Leaf spectrum of *C.* 'Brett Gaff' (Phipps & O'Kennon 8537, 8817), top, and comparison of *C. sheila-hippsiae* varieties, bottom. Specimens used for latter: Phipps & O'Kennon 7015a, 8338 (var. *sheila-hippsiae*—left infructescence with thorn; bottom inflorescence); Phipps & O'Kennon 8657, 8858 (var. *saskatchewanensis*—right infructescence with thorn; top inflorescence). S. Laurie-Bourque del.; scale bars equal 1 cm.

Bush, often thicket-forming, 1.5–2.5 m in open, 2–4 m under aspen; extending twigs thinly pubescent, often reddish; at one year tan to mid-brown; two-year old brown, grayed, older gray to gray-brown; thorns moderately frequent, mainly 3–5 cm long, straight or more often curved, usually  $\pm$  slender to moderately stout, dark shiny red-brown at two years. Leaves deciduous; petioles 30–45% length of blade, usually glabrous (but occ. dense-pubescent), except for adaxial sulcus, bearing small sessile glands; blades 3–4.5 cm long at maturity, 2–3.5 cm at anthesis, rhombic, rhombovate or trullate-ovate in general shape, base cuneate, apex acute; lobes 2–3(–4)/side, max. LII mainly 15–25 %; margins with very small acute to subacute teeth; venation craspedodromous, usually 3–4 main veins per side; adaxially  $\pm$  densely appressed scabrous-pubescent young, variably persistent till maturity; abaxially glabrous on the surface, main veins glabrous to thinly pubescent. Inflorescences 4–10 flowered; branches usually moderately to very densely (less commonly) pubescent, bearing caducous, small, pallid to light brown, narrow-oblong, gland-margined bracteoles. Flowers 14–16(–18) mm diam.; hypanthium usually glabrous to thin-pubescent, especially below, rarely densely pubescent; calyx-lobes triangular, 3–4 mm long, adaxially thinly pubescent, abaxially glabrous, margins glandular but barely serrate, pallid to light green; petals  $\pm$  circular, white; stamens ca. 10, anthers ivory; styles 3–4. Infructescences 1–5 fruited; branches subglabrous to moderately pubescent. Fruit 9–11 mm high, broad-elliptic to subglobose, bright orange-red, finally becoming bright or deep red; calyx-lobes spreading; nutlets 3–4, laterally  $\pm$  plane or sometimes shallowly concave, dorsally grooved.

*Common name.*—Fireberry Hawthorn.

*Distribution* (Fig. 24).—*Crataegus chrysocarpa* is one of the two most wide-ranging hawthorns in North America, reaching from the inland valleys of Oregon, Washington and British Columbia to the Atlantic coast in a broad band on both sides of the Canada-United States border and as such it is rather variable overall



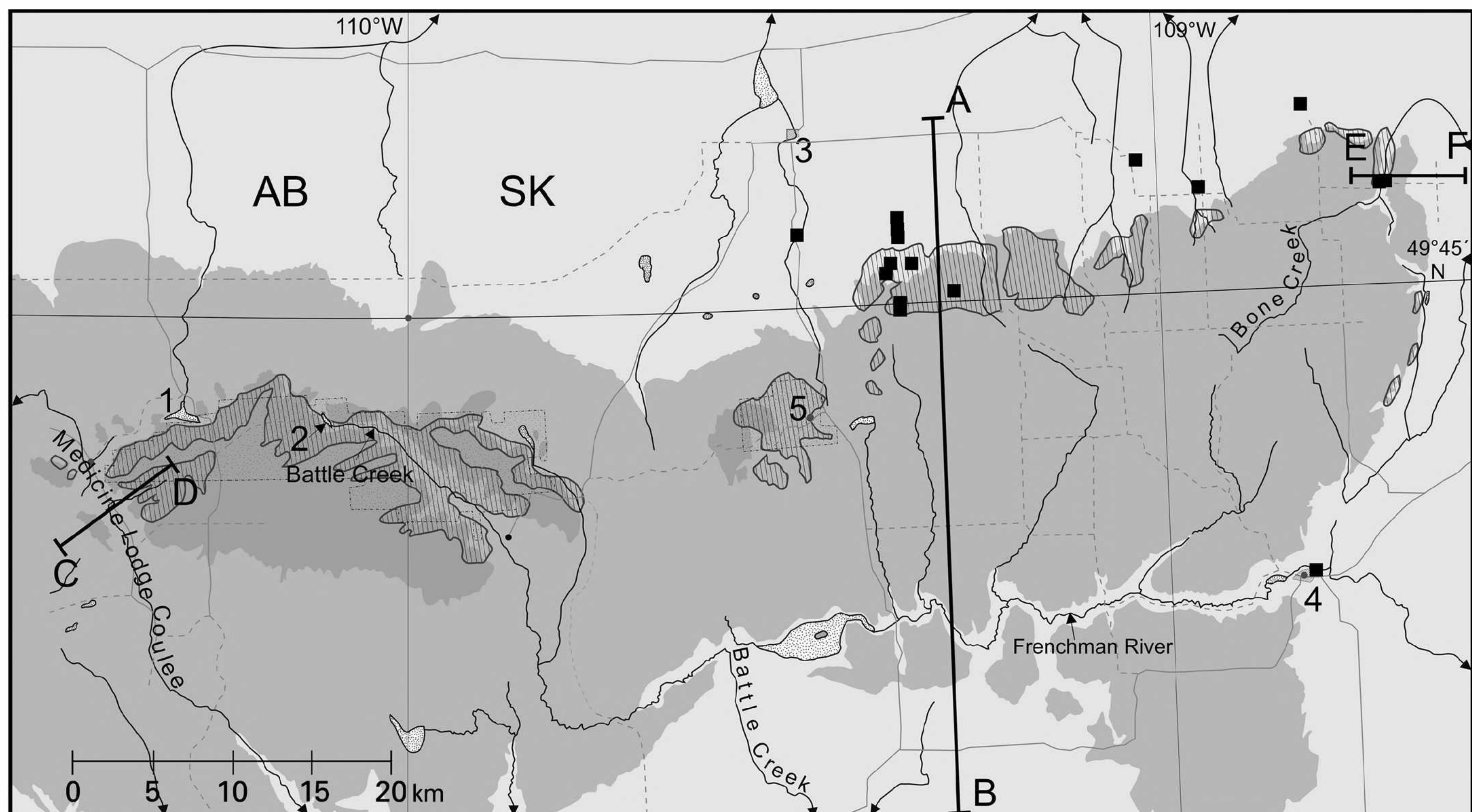


FIG. 26. Map of *C. sheila-hippsiae* var. *saskatchewanensis* distribution in the Cypress Hills. Base map same as for Fig. 2.

though not particularly so in the Cypress Hills. In the Canadian Prairies as a whole *C. chrysocarpa* is by far the most widespread and common hawthorn while in the Cypress Hills it is most abundant at the lower altitudes, most usually in thickets in draws lacking shade of aspen, but is also found in light shade. As one reaches the driest sites in which hawthorns occur in the Cypress Hills *C. chrysocarpa* will be one of the few hawthorn species present.

The Cypress Hills forms mostly represent a regionally common form for the species with broad-ovate to rhomb-ovate leaves,  $\pm$  hairy inflorescence branches, hypanthium glabrous or at most slightly hairy below, shortish thorns and 10 stamens with white anthers. Occasional variation in pubescence is found with a locally rare, particularly hairy form densely pilose on the inflorescence branches and flowering hypanthium, usually quite persistent into fruit. Ripe fruit is also occasionally golden, instead of bright or orange red. Old fruit may be dark red. The type has rather hairy,  $\pm$  globose fruit and four plane-sided nutlets, representing a common leaf-type in the species. *Crataegus chrysocarpa* is of lower stature at maturity than most of the other species treated here. It has been badly confused in the past with *C. rubribracteolata* and *C. sheridana*, which see for comments.

**12. *Crataegus sheila-hippsiae*** J.B. Phipps & O'Kennon var. ***saskatchewanensis*** J.B. Phipps & O'Kennon, var. nov. (Plate 7.4c; Fig. 25). TYPE: CANADA. SASKATCHEWAN: Cypress Hills, lower northern slopes, Maple Creek Rural. Mun., north-south road crossing Hay Creek, alt. 856 m, 24 May 2004, J.B. Phipps & R. O'Kennon 8654 (HOLOTYPE: UWO; ISOTYPES: CAN, SASK, DAO).

Differt constanter a var. *sheila-hippsiae* modo minus arboriformi; spinis plerumque multo longioribus (3–6 cm vs. 2.5–4 cm) et multo validioribus; foliis multo minoribus, praesertim in anthesi (in maturitate 2.5–4(–5) cm vs. 4–5 cm); ramulis inflorescentiarum sparsim pilosis praecipue proximaliter; antheris albis non roseis; fructibus aurantiaco-rubris vel scarlatinis.

Thicket-forming shrub 1.5–3 m tall; extending shoots green, glabrous; one year old twigs smooth, dark brown, older gray or dark gray; thorns usually frequent, 3–6 cm long, straight to somewhat recurved, moderately stout, shiny dark red-brown at two years, darker with age. Leaves deciduous; petioles 25–40% length of blade,  $\pm$  glabrous except pubescent in adaxial sulcus, bearing several small, sessile glands; blades 2–4(–5) cm long, about half that size at early anthesis, rhombic, rhomb-ovate or rhomb-elliptic in general



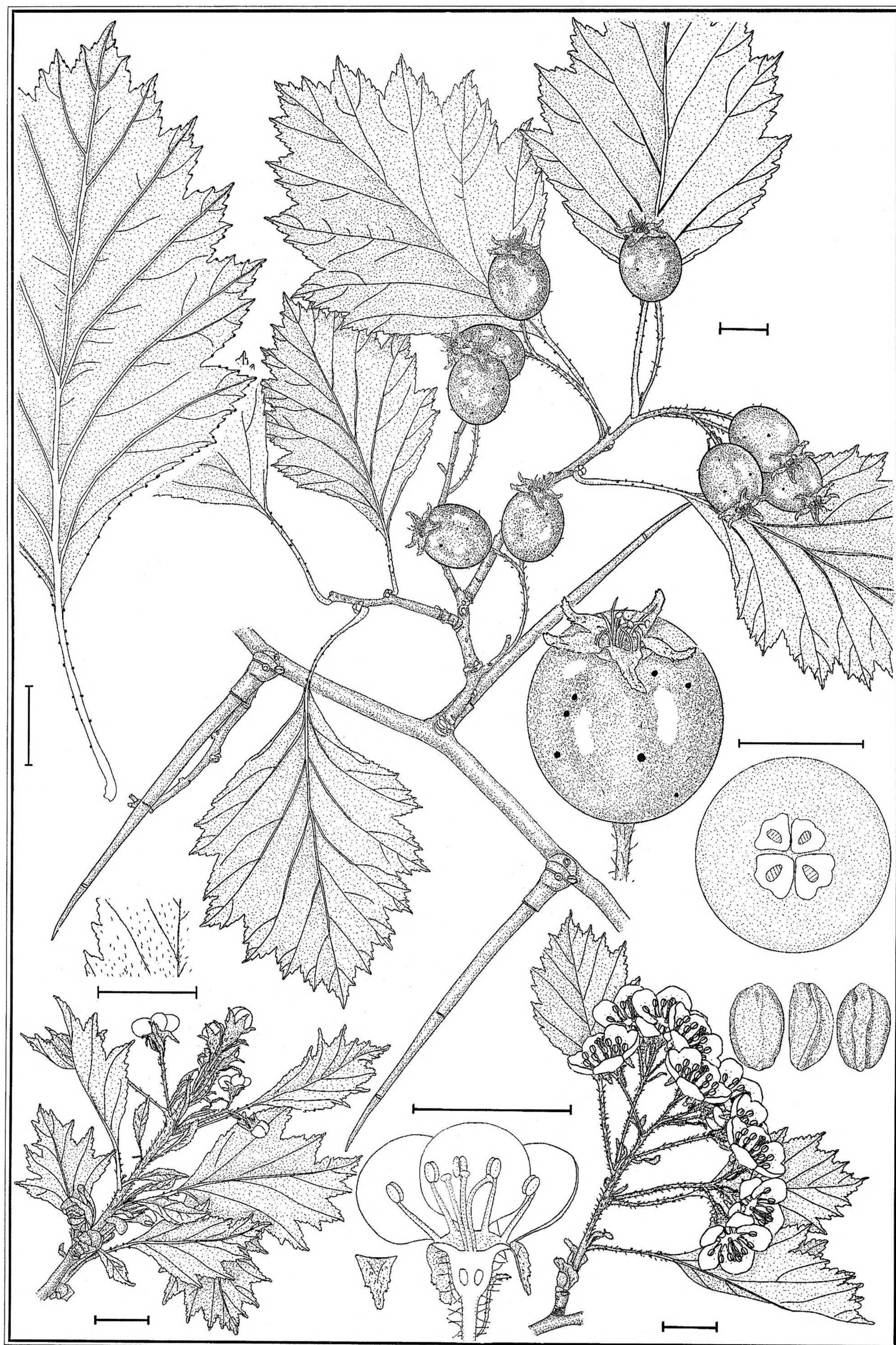


FIG. 27. Line drawing of *C. ursopedensis*. Specimens used: Phipps & O'Kennon 8741a, 8949, 8975 (flowering); Phipps & O'Kennon 8547, 8587 (fruiting). Young inflorescence shows expanding leaves; numerous bracteoles. Mags show whole leaf abaxial surface, pubescence on part young leaf adaxial surface, flower section and calyx-lobe, fruit and nutlets. S. Laurie-Bourque del.; scale bars equal 1 cm.



shape, base cuneate to broad cuneate, apex acute to acuminate; lobes 2–3 per side, these acute to acuminate, max LII 15–30%; margins with numerous, small, acuminate to acute teeth; venation craspedodromous, 4–5 main lateral veins per side; adaxial surface  $\pm$  densely appressed-pubescent young, this usually persistent to maturity, abaxially glabrous except sometimes for a few thin hairs on the major veins. Inflorescences 3–10 flowered; branches subglabrous to very sparsely pilose proximally, bearing caducous, narrow, membranous, pallid, densely gland-bordered bracteoles. Flowers 16–20 mm diam.; hypanthium glabrous; calyx-lobes ca. 3 mm long, triangular, glabrous on both surfaces, margins glandular-denticulate, greenish; petals  $\pm$  circular, white; stamens about 20, anthers white or cream; styles usually 3–4. Infructescences with 1–7 fruit; pedicels glabrous. Fruit 10–12 mm tall, turbinate to subglobose, orange red to bright red, sometimes blotched green at maturity; calyx-lobes erose or reflexed; nutlets 3–4, plane laterally, grooved dorsally.

*Common name.*—Saskatchewan Hawthorn.

*Distribution* (**Fig. 26**).—This is a generally common species at the lower altitudes (<1100 m) in the eastern Cypress Hills, appearing more abundant in thickets than in aspen. It is also known from prairie areas in Saskatchewan well to the north of the Cypress Hills but its overall distribution remains unclear due to its earlier confusion with *C. chrysocarpa*. Ledingham made the first Cypress Hills collection (# 8922) in the Saskatchewan Centre Block, but named his specimen *C. douglasii*.

*Crataegus sheila-hippsiae* var. *saskatchewanensis* is a typical member of the *C. chrysocarpa* group with its  $\pm$  rhombic, small leaves, relatively low shrubby stature and plane-sided nutlets. As a species it is distinguished by 20 stamens and  $\pm$  glabrous pedicels. The new variety here described differs from the type variety, which is much localized and restricted to the northern British Columbia Okanagan, by its less tree-like habit, generally longer thorns, smaller leaves which at early anthesis are particularly small and white rather than pink anthers (Figs. 5a, 5b1).

In Cypress Hills populations it is surprising how easy this species is to identify in flower or in fruit, once known, without having to approach close enough to note its lack of inflorescence pubescence and 20 stamens.

**13. *Crataegus ursopedensis*** J.B.Phipps & O'Kennon, sp. nov. (**Plates 6.1d, 7.4d; Fig. 27**). TYPE: U.S.A. MONTANA. Hill Co.: Beaver Creek Park at 1220 m., below aspen, 19 Sep 2003, J.B. Phipps & R. O'Kennon 8589 (HOLOTYPE: UWO; ISOTYPES: C.AN, DAO, MO, SASK, TRT, US).

Frutices 2–3(–4) m alti; squamae expansae gemmarum aurantiaco-cervicolores vel pallidiores; ramuli prorecti pubescentes; annotini nitenter rubro-brunnei; post secundum annum rubro-brunnei cum maculis blancis, veteriores cinerei; spinae plerumque abundantes, (3–)4–7 cm longae, post secundum annum nitenter peratrorubro-brunneae,  $\pm$  validae,  $\pm$  rectae vel recurvatae. Folia decidua; petioli 30–45% longitudinis laminae, sulco adaxiali pubescente in maturitate, aliter glabro, cum paucis vel  $\pm$  numerosis glandibus sessilibus; laminae 5.5–9.5 cm longae (saepe solo 2–3 cm in anthesi quum etiam perflabellatae), ovatae vel ovato-trullatae in forma generali; bases cuneatae vel angusto-cuneatae; apices acuminati; lobi 4–5 per latus, acuti vel acuminati, max. IFI 25–35%; margines cum numerosis parvis,  $\pm$  acutis dentibus; venatio craspedodroma, plerumque 5 venis principalibus per latus; pubescentia adaxialis dense appresso-scabro-pubescent in juventute, in maturitate subglabra; pubescentia abaxialis glabra nisi interdum sparsim vel moderate dense pubescens secundum venas principales in juventute. Inflorescentiae (1–)5–12 floratae, lato-patentes in anthesi plena; ramuli moderate dense pubescentes, ferentes caducas angusto-ellipticas, cremeas vel pallide virides, saepe suffusas pallide rubras distaliter praesertim, perglandulosas, membranaceas bracteolas quae in squamas gemmarum gradatim se versari. Flores 15–18 mm diam.; hypanthium varie pubescens infra,  $\pm$  glabrum supra; lobi calycis 4–5 mm longi, triangulares, pallide virides vel scariosi, adaxialiter leviter pubescentes, abaxialiter glabri, marginibus glanduliferis vel glandulo-denticulatis; petala  $\pm$  circularia, alba; stamina ca. 10, antheris eburneis; styli 3–4. Infructescentiae 1–8 fructatae; ramuli pubescentes, interdum solo tenuiter. Fructus 8–11 mm alti, plerumque ellipsoidei vel oblongi, varie pubescentes, aurantiaco-rubri primo, postea aurantiaco-rubri vel clare rubri; lobi calycis patentes vel  $\pm$  appressi, 3–4 mm longi; pyrenae 3–4, lateribus  $\pm$  planis vel leviter concavis, sulcatae dorsaliter.

Bushes 2–3(–4) m tall; expanding bud-scales orange-tan or paler; extending twigs pubescent; one year old shiny red-brown; two year old red-brown with white flakes, older gray; thorns usually plentiful, (3–)4–7 cm long, at two years shiny very dark red-brown, fairly stout,  $\pm$  straight to recurved. Leaves deciduous; petioles 30–45% of length of blade, adaxial sulcus pubescent at maturity, otherwise glabrous, with few to  $\pm$  numerous sessile glands; blades 5.5–9.5 cm long (often only 2–3 cm at early anthesis when also very flabellate), ovate to ovate-trullate in general shape; base cuneate to narrow cuneate, apex acuminate; lobes



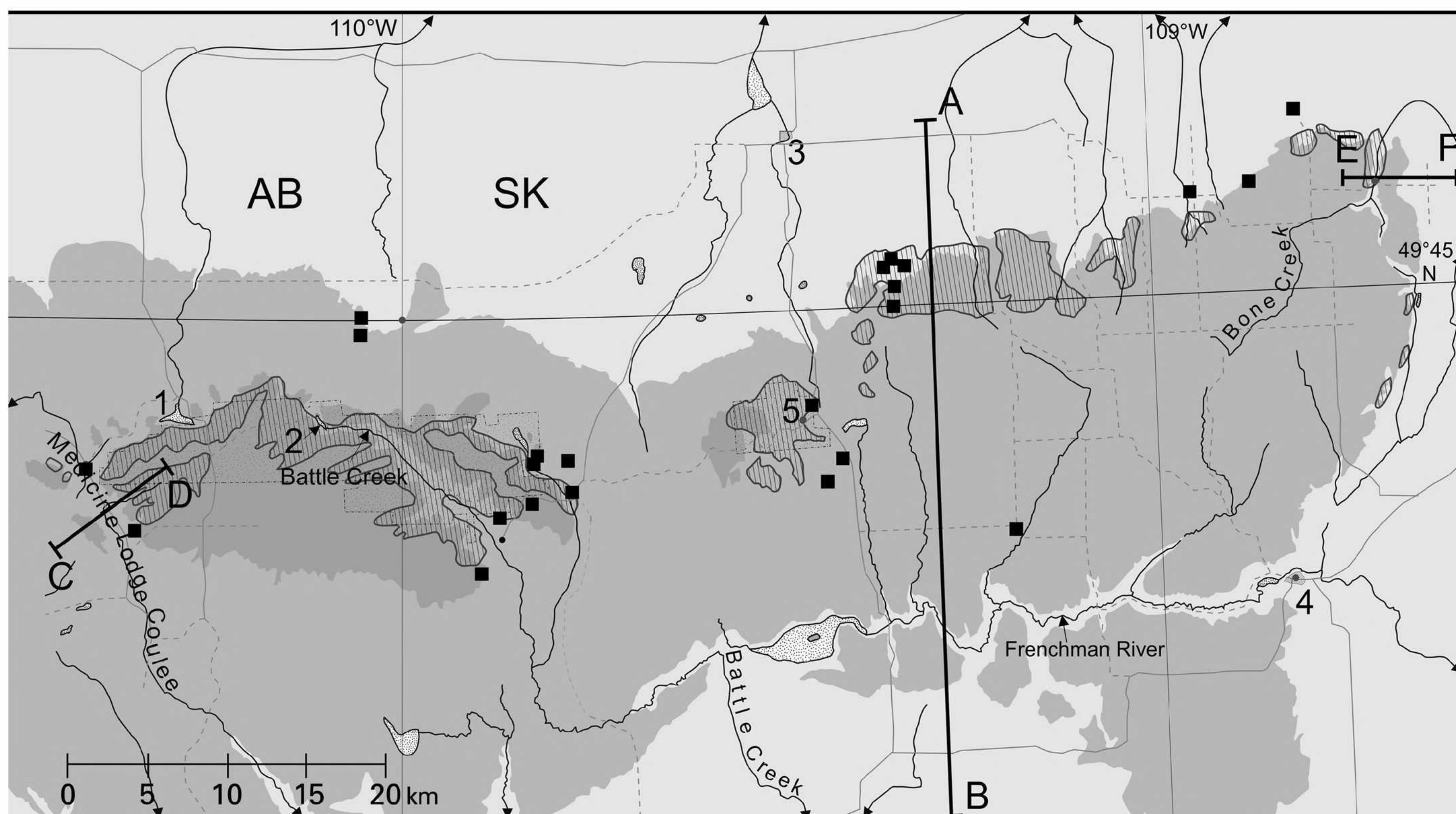


FIG. 28. Map of *C. ursopedensis* distribution in the Cypress Hills. Base map same as for Fig. 2.

4–5 per side, acute to acuminate, max. LII 25–35%; margins with numerous small,  $\pm$  acute teeth; venation craspedodromous, usually 5 main veins per side; adaxially densely appressed scabrous-pubescent young, at maturity subglabrous, abaxially glabrous except for sometimes thin to moderately dense pubescence along the main veins young. Inflorescences (1–)5–12 flowered, widely spread at full anthesis; branches moderately densely pubescent, bearing caducous, narrow elliptic, cream to pale green, often suffused light red especially distally, very glandular, membranous bracteoles that appear to grade into bud scales. Flowers 15–18 mm diam.; hypanthium variably pubescent below,  $\pm$  glabrous above; calyx-lobes 4–5 mm long, triangular, pale green to scarious, adaxially slightly pubescent, abaxially glabrous, margins glandular to glandular denticulate; petals  $\pm$  circular, white; stamens ca. 10, anthers ivory; styles 3–4. Infructescence 1–8 fruited; branches pubescent, sometimes only thinly so. Fruit 8–11 tall, mainly ellipsoid or oblong, variably pubescent, orange-red early, later orange-red to bright red; calyx lobes spreading to  $\pm$  appressed, 3–4 mm long; nutlets 3–4, sides  $\pm$  plane to slightly concave, dorsally furrowed.

*Common name.*—Bear's Paw Hawthorn.

*Distribution (Fig. 28).*—*Crataegus ursopedensis* is found throughout the Cypress Hills in suitable habitats though it seems most common in Saskatchewan. There are fine stands of it also in the Bear's Paw Mountains, Montana, along Beaver Creek at around 1200 m where the first record was discovered by us after seeing a sterile specimen at the herbarium at Montana State University at Havre. Other than our own collections this is the only known specimen. The species is named for the Bear's Paw Mountains although it is far more abundant in the Cypress Hills. It is found in the usual habitats for *Crataegus* in the Cypress Hills.

Bear's Paw Hawthorn can have strikingly large, deeply and sharply incised leaves to 9.5 cm long under favorable conditions although they are often rather smaller and then difficult to tell, particularly at maturity, from the Red Bracteole Hawthorn. The leaves tend to be more glossy at maturity than in that species, the inflorescence is more open, the petioles are relatively longer, but materially the bracteoles much paler (Plate 6.1d) and, the nutlets sides more nearly plane than in *C. rubribracteolata*. This ensemble of characteristics appears to relate *C. ursopedensis* to *C. chrysocarpa* and other species in that part of ser. *Rotundifoliae*. Also see discussion under *C. rubribracteolata*.



### 13a. unnamed variants

Two variant forms have been seen that will key out under *C. ursopedensis*. Both have broadly elliptic leaves. These are: (i) a very hairy form with dark green, rather glossy, convex leaves rather smaller than and generally differently lobed from *C. ursopedensis*, and with bright red fruit, labeled 'Brett Gaff' in Fig. 25 (upper), only with certainty at Shafer Creek, SK but possibly more widespread as in the unnamed specimen in Fig. 4b; and (ii) a form with often fairly deeply impressed veins, leaves often smaller and rather more sharply lobed than in *C. ursopedensis*, from localities in the area of the headwaters of Dimmock Creek, Bridge Creek and Skull Creek as well as from Bone Creek Coulee, all in the northeast of the Cypress Hills. More material and further study will be required to clarify their taxonomic status.

### BIOGEOGRAPHY

Thirteen species of *Crataegus* are now reported for the Cypress Hills. These species vary greatly in their overall distribution from continent-wide species to, as far as is presently understood, endemic species. With such widely different distributions it may be anticipated that there is some degree of niche differentiation with respect to their habitats but so far there exist no studies on any species of *Crataegus* that address such matters in any detail so that only a few broad generalizations are possible. These derive mainly from observing situations where species are sympatric. Even so, in the Cypress Hills, as in many parts of the range of *Crataegus*, different species, often of similar stature, may be found flourishing in the same thicket and other such thickets may also hold a similar mix of species so that it is not merely some random association that is observed but that their ecological requirements are broadly similar. In spite of this some differences have been observed which will be alluded to later.

The main biogeographic patterns observed are as follows:

#### a). Continent-wide taxa

The only species in this group are *C. chrysocarpa* and *C. macracantha* both of which extend from intermontane regions quite close to the Pacific Ocean across to the Atlantic. *Crataegus chrysocarpa* is the more northerly of the two and throughout its range it is the most northerly species of *Crataegus* on the continent. It does not extend very far south into the United States except at altitude. On the other hand, *C. macracantha* does not extend very far into Canada and its southern limits are consistently hundreds of kilometers to the south of *C. chrysocarpa* in the United States. *Crataegus chrysocarpa* occurs somewhat locally in more mesic sites in the dry prairies whereas *C. macracantha* is less likely to occur there.

#### b). Cordilleran taxa

Two species are primarily Cordilleran, the rather variable *C. douglasii* and the much more uniform *C. castlegarensis*. Both have range extensions to disjunct populations in mesic areas to the east of the Rocky Mountains.

#### c). Taxa restricted to mesic montane islands in the Great Plains

Six or perhaps seven species are in this group and each is of quite restricted range. All are newly described in this paper. They are *C. cupressocollina*, *C. rivuloadamensis*, *C. rivulopugnesis*, *C. purpurella*, *C. aquacervensis*, *C. ursopedensis* and perhaps *C. rubribracteolata* (this last may get referred to the next group eventually). *Crataegus rivuloadamensis*, *C. rivulopugnesis*, *C. purpurella* and *C. aquacervensis* are at present knowledge restricted to the Cypress Hills while the other two have also been found in the Bears Paw Mountains. It may be noted that, in spite of their restricted ranges, all are locally abundant species in the Cypress Hills. Indeed, *C. cupressocollina* is one of the commoner and more distinct species found there where it is much more abundant than *C. douglasii*.

#### d). Taxa primarily of the Great Plains but not confined to mesic montane islands

The most striking example in this category is the resurrected species *C. sheridana* which has a wide but currently incompletely understood range from Wyoming to Saskatchewan. In addition, there are the inadequately documented *C. sheila-hippsiae* var. *saskatchewanensis*, new in this paper and only from Saskatchewan so far (var. *sheila-hippsiae* is from British Columbia) and *C. rubribracteolata* also new to this paper and which is



known from the Cypress Hills and Bears Paws with suggestions of occurrence in the surrounding prairie areas.

Comparisons with *Crataegus* floras in montane islands in Montana have to be treated with caution as the Montana *Crataegus* floras are not yet been studied in the same detail. The Bears Paw Mountains have the same suite of species as the Cypress Hills except, naturally, for the latter's endemics and appear to have no species not found in the Cypress Hills. In the Bears Paws hawthorns are not nearly as abundant as in the Cypress Hills and are mostly restricted to the Beaver Creek valley which flows north towards Havre. In the still smaller area of the Sweet Grass Hills, only three species of hawthorn have been found, all widespread species, while in the Highwood Mountains five more or less widespread hawthorn species (*C. douglasii*, *C. castlegarensis*, *C. macracantha*, *C. sheridana* and *C. chrysocarpa*) are now known. However, at this juncture, only the *Crataegus* flora of the Bears Paw Mountains, among the Montana montane islands, is reasonably well known to us.

In summary *Crataegus* in the Cypress Hills is much more speciose and seemingly far more numerous in individuals than any other discrete area between the Rocky Mountains and Minnesota at which point mesicity in topland soils begins to get back to optima for *Crataegus*. There is no single predominant biogeographic relationship of this *Crataegus* flora although it should be noted that there are no species present with primarily eastern distributions. The *Crataegus* species of the Cypress Hills appear to range from fairly drought tolerant, e.g., *C. sheridana*, *C. chrysocarpa*, to more mesophytic types characterised by the Cypress Hills endemics, *C. cupressocollina* and the race of the variable *C. douglasii* that occurs there.

#### ORIGINS OF THE CYPRESS HILLS *CRATAEGUS* FLORA

As discussed in the section on origins of woodland in the Cypress Hills (pp. 1038–39), in the absence of firm data from the fossil record, etc., or convincing arguments from molecular evidence, one can only guess at times of origin of different species based to some extent on phenetic similarities and distributions. There is no direct evidence bearing on the age of any of the *Crataegus* species restricted to montane mesic islands such as the Cypress Hills and the latter, although not completely glaciated (parts of summit plateau remained unglaciated), have only presented conditions suitable for hawthorns over the last 10–12,000 years at most. Indeed the Holocene Zone I, from about 9000 to 6400 B.P., is a more likely starting point for *Crataegus*, taking into account general *Crataegus* temperature and mesicity preferences, and it is also likely that hawthorn beginnings in the Cypress Hills were several events, not one. This position is supported by the widely different biogeographic patterns of the various species and their ecological differences so far as understood. However, it is possible that the remarkable restricted distributions of *C. cupresso-collina*, *C. rubribracteolata*, *C. ursopedensis*, *C. aquacervensis*, *C. rivuloadamensis* and *C. purpurella*, all at least locally common in the Cypress Hills, may reflect relatively recent evolution, even if not entirely Holocene.

An interesting feature for which it is not possible to determine the explanation at present is the differing distribution patterns among the Cypress Hills hawthorns within the hills themselves. Broadly speaking, most taxa occur more or less throughout the hills from west to east in suitably mesic hawthorn habitats, although there is preference for a higher altitude distribution pattern in some species and a lower altitude pattern in others. Examples of this are noted with particular species in the text. However, four of our taxa, *C. sheridana*, *C. sheila-hippsiae*, *C. cupressocollina* and *C. purpurella*, are found predominantly in the Saskatchewan part of the Hills, see distribution maps (Figs. 7, 16, 23, 26), while three, *C. aquacervensis*, *C. rivuloadamensis* and *C. rivulopugensis*, are found mainly west of a line through Adams Creek (Figs. 12, 14, 18). These patterns might reflect relatively recent starting points within the Cypress Hills as there is no discernible significant east-west ecological difference between the eastern and western halves. A second possibility is that the endemics might be nothing more than relict species, unlikely though this might seem. Such a view would be more conformable with the observation that no other plant endemics are known from the Cypress Hills. No other plant genera, so far as we know, have species that make this distributional distinction. At present it is perhaps plausible, at most, that the Cypress Hills endemics originated during the Holocene but not necessarily within the Cypress Hills. In the cases of *C. sheridana* and *C. sheila-hippsiae*, however, the



reduced distributions observed to date are perhaps only an artefact of undercollecting along a number of rather inaccessible but otherwise seemingly appropriate north-draining draws in Alberta.

The existence of pairs of rather similar *Crataegus* species in the Cypress Hills flora might also be taken to suggest relatively recent divergence or alternatively, if any are of hybrid origin, similar but different origins in different locations. These pairs are:

[*C. purpurella*\* and *C. rivulopugnensis*\*]

[*C. aquacervensis*\* and *C. rivuloadamensis*\*]

[*C. ursopedensis*\* and *C. rubribracteolata*\*]

[*C. chrysocarpa* and *C. sheila-hippisiae* var. *saskatchewanensis*]

of which the asterisked taxa are restricted to the Cypress Hills and their immediate surrounds or the Bears Paws as well. The existence of such rather similar pairs might also lend support to the idea of recency of origin although it must be noted that in all these our cases the individual species can be straightforwardly differentiated with adequate material. This, together with their relative abundance therefore suggests that they are (already) behaving as good species. The biogeographical patterns noticed here for *Crataegus* in the Cypress Hills have not received previous mention either for *Crataegus* or other plant genera.

#### CONCLUSIONS

The Cypress Hills flora contains 13 distinct *Crataegus* species, 10 or 11 more than in the literature. Of these, seven species and one variety are new to science. Although some specimens of all but two (*C. castlegarensis* and *C. macracantha*) of the Cypress Hills hawthorns had been collected by earlier workers (see cited specimens) only very few species of these had been recognized by them as being present. *Crataegus cupressocollina*, *C. aquacervensis*, *C. rivuloadamensis*, *C. rivulopugnensis*, *C. purpurella*, *C. rubribracteolata*, *C. ursopedensis* and *C. sheila-hippisiae* var. *saskatchewanensis* are new to science while *C. sheridana* is resurrected from its type description where it had languished for over 100 years except for occasional appearances as a synonym and this species is therefore effectively also new to general knowledge. All the new taxa can be straightforwardly distinguished with adequate material even if they have superficial similarity. The substantial numbers of individuals of each suggest that even in the case of the newly described taxa, they are behaving as distinct species. Boxplots of 8 selected continuous variables add to this conviction.

Five of the previously known species are wide-ranging taxa that cross both major vegetation and floristic boundaries of Barbour & Christenson (1993) and Thorne (1993) and two of these, *C. castlegarensis* and *C. sheila-hippisiae*, represent significant range extensions of previously known species. Two of the wide-ranging species (*C. douglasii* and *C. castlegarensis*) are western cordilleran to mid-continent taxa and the other two, *C. chrysocarpa* and *C. macracantha*, constitute the two most wide-ranging North American *Crataegus* species, occurring from the western cordilleras to the Atlantic. One of the species newly recognized as present, *C. macracantha*, proves to be quite common in the Cypress Hills particularly at lower altitudes on the northern slopes, but does not appear to have been previously collected there, while *C. sheridana*, on present evidence, is also widespread in the Great Plains. Of the seven species new to science, four are, at present knowledge, Cypress Hills endemics, three are almost endemic species (a few plants are also known from Bears Paw Mountains, MT). *Crataegus cupressocollina*, new to science and arguably the most distinct of all the Cypress Hills species, may be the most abundant hawthorn in the Cypress Hills.

The vegetation of the Cypress Hills is discussed for the purpose of better understanding hawthorn habitat. This is done in the context of 'CMI', a moisture index which apparently is the best single predictor of distribution patterns of plant species for the Great Plains. Relevant CMIs range from negative (prairie grassland) to 15+ (coniferous forest). Aspen occurs mainly between 1 and 15. Hawthorns thrive in the more mesic aspen woodland with a presumed CMI of about 10–15 and in creek thickets in prairie grassland. It is clear that in the Great Plains, at least, *Crataegus* responds more to a particular position on a moisture gradient (including accepting supplemental water as substitute along creek beds) and to a particular light regime than to precise soil type except for rejecting sandy soils. Thus the mesic island of the Cypress Hills becomes a suitable home to an estimated millions of hawthorns, far in excess of any other bushy plant. All



the species discussed are mesomorphs with the most xerophilic tendencies being found in *C. chrysocarpa*, *C. rubibracteolata* and *C. sheridana*.

The origins of the woody vegetation of the Cypress Hills are discussed and are entirely post-glacial. The successive zones of Holocene vegetation are summarized from work by David Sauchyn and others and extrapolation used to consider possible times of arrival of *Crataegus* species in the context of their varied biogeography and other factors. Because *Crataegus* fossilizes poorly (no relevant fossils have yet been recorded) speculation about arrival time has to be made on such matters as the pollen record for other woody species. From this line of thinking the level of endemism unearthed suggests the possibility that the Cypress Hills may represent an active area of recent hawthorn evolution. If so, it would be helped by the favorable climate and habitat that has allowed huge populations to develop, a situation not unlike the northern Okanagan of British Columbia, another location of favorable climate and large *Crataegus* populations at the same latitude, the *Crataegus* flora of which has been extensively investigated by the authors.

#### APPENDIX

##### FURTHER CITED SPECIMENS

*Notes.*—Arrangement of taxa is alphabetical; non-JBP numbers with collection information in full; JBP numbers data abbreviated to season and province; numbers with asterisk = Alberta collections; without asterisk = Saskatchewan collections; subtotals given for last two categories. Most JBP numbers are Phipps and O'Kennon collections.

#### 1. *Crataegus aquacervensis*

##### a) non-JBP specimens (12):

**Alberta:** Cypress Hills, no locality, 14 Aug 1947, *Breitung, A.J.* 5597 (DAO). Cypress Hills, hillside above Elkwater Lake, 16 Jun 1930, *McCalla, W.C.* E3728 (ALTA). **Saskatchewan:** Cypress Hills Park, no locality, 27 May 1949, *Budd, A.C.* 1305 (xerox) (SASK). Cypress Hills Park, no locality, 20 Aug 1935, *Bolton, J.L.* in SASK 111546 (xerox). Cypress Hills, no locality, 15 Aug 1926, *Clarke, S.E.* in SASK 111552 (xerox). Cypress Hills, no locality, 15 Aug 1936, *Bolton, J.L.* 186 (xerox) (SASK). Cypress Hills Park, no locality, 14 Jul 1947, *Breitung, A.J.* 4776 (xerox) (SASK). Cypress Hills, no locality, 07 Sep 1950, *Budd, A.C.* 1927 (xerox) (SASK). Cypress Hills Prov. Park, Centre Block, along beaver-ponded stream(s) of Loch Lomond, 10 Jul 1986, *Harms, V.L. & R.M.* 36371 (xerox) (SASK). Cypress Hills Prov. Park, Centre Block, along beaver-ponded stream(s) of Loch Lomond, 10 Jul 1986, *Harms, V.L. & R.M.* 36370 (xerox) (SASK). Piapot, Bear Creek Forest Reserve, 02 Jun 1938, *Budd, A.C.* 111548 in SASK (xerox).

##### b) JBP numbers (26\*, 9):

**Aug–Sep 2001:** 8227\*. **Aug–Sep 2003:** 8515\*, 8521\*, 8524\*, 8526\*, 8527\*, 8528\*, 8530\*, 8532\*. **May–Jun 2004:** 8723\*, 8727\*, 8738a, 8754, 8755, 8772\*, 8774\*, 8775\*, 8778\*. **Aug–Sep 2004:** 8791\*, 8794\*, 8796\*, 8804\*, 8810\*, 8831\*, 8906, 8912. **May–Jun 2005:** 8942, 8967, 8969, 8971, 8989\*, 8991\*, 8995\*, 9002\*.

#### 2. *Crataegus castlegarensis*

##### a) non-JBP specimens (0).

##### b) JBP numbers (10\*, 20):

**Aug–Sep 2001:** 8221\*, 8226\*, 8228\*, 8229\*, 8230\*, 8231\*, 8232, 8236, 8244. **Aug–Sep 2003:** 8523\*, 8531\*, 8536, 8546, 8571, 8613, 8626, 8792\*. **May–Jun 2004:** 8681, 8683, 8738, 8746, 8750, 8761, 8773\*. **Aug–Sep 2004:** 8844, 8881, 8894. **May–Jun 2005:** 8932, 8982, 9003.

#### 3. *Crataegus chrysocarpa*

##### a) non-JBP specimens (9):

**Alberta:** Cypress Hills Prov. Park, S of Girl Guide camp, 09 Jun 1964, *de Vries, B.* 1896 (DAO). Cypress Hills Prov. Park, along small trail E of main campsite, 06 Jun 1964, *de Vries, B.* 1918 (DAO). Cypress Hills, on Brown Ranch along Ventre Creek Valley, N of Cypress Hills, 29 May 1978, *Bradley, C.* 84434 (ALTA). Deer Creek Ranch (Gilchrist), 10 Jun 1975, *Klar, A.* 1078 (ALTA). Cypress Hills Prov. Park, Braun Coulee, Nott's Coulee, 13 Jun 1945, *Cormack, R.G.H.* 62 (ALTA). near Manyberries, 22 Jun 1946, *Moss, E.H.* 7016 (ALTA). **Saskatchewan:** N side of Cypress Hills, ca. 20 km E of Elkwater, 15 Sep 1995, *Macdonald, I.D.* in SASK 137785. Cypress Hills, Fort Walsh, 20 Aug 1947, *Breitung, A.J.* 5692 (DAO).

##### b) JBP numbers (16\*, 23):

**Aug–Sep 2001:** 8217\*, 8234, 8235, 8239, 8583\*. **Aug–Sep 2003:** 8525\*, 8608, 8622, 8846. **May–Jun 2004:** 8644, 8662, 8684, 8694, 8702, 8704, 8710, 8712, 8714, 8716, 8725\*, 8741, 8744, 8758, 8770\*, 8776\*. **Aug–Sep 2004:** 8797\*, 8799\*, 8814\*, 8815\*, 8846\*, 8824\*, 8826\*, 8838\*, 8885. **May–Jun 2005:** 8933, 8953, 8961\*, 8980, 9006\*.



**4. *Crataegus cupressocollina*****a)** non-JBP specimens (12):

**Saskatchewan:** Cypress Hills Prov. Park, W Block, 21 Sep 1984, *Ledingham, G.F.* 8932 (USAS). Cypress Hills Park, Centre Block, 28 Aug 1990, *de Vries, B.* in USAS 278390. Cypress Hills, Battle Creek Ranger Station, 17 Aug 1947, *Breitung, A.J.* 5672 (ALTA). Cypress Hills, W block ¼–1½ km SE of AB border, 23 Jun 2003, *Harms, V.L.* 44175 (SASK). Cypress Hills Park, Battle Creek Ranger Station, 17 Aug 1947, *Breitung, A.J.* 5672 (DAO). Cypress Hills Park, no locality, 25 Jul 1949, *Breitung, A.J.* 8065 (DAO). Cypress Hills Park, valleys, 14 Jul 1947, *Breitung, A.J.* 4776 (DAO, SASK). Cypress Hills Park, shore of Loch Leven, 25 Jul 1949, *Breitung, A.J.* 8065 (CAN, SASK). Cypress Hills Park, W Block, 16–17 Jun 1951, *Porsild, A.E.* 17920 (CAN). Cypress Hills Prov. Park, along Lake Leven near Park Hdqts., 27 Sep 1969, *Boyce, R.* in SASK 40840. Cypress Hills, no locality, 20–25 Jul 1949, *Carmichael, L.T.* 336 (DAO). Cypress Hills Prov. Park, Centre Block, vicinity of Loch Lomond, Jun 2003, *Nagel-Hisey, M.* 1 (UWO).

**b)** JBP numbers (4\*, 57):

**Aug–Sep 2001:** 8238, 8241, 8243, 8246, 8247, 8249, 8250. **May–Jun 2003:** 8485, 8487, 8491, 8493, 8496, 8501, 8503, 8504, 8506, 8508, 8509\*, 8510\*. **Aug–Sep 2003:** 8519\*, 8538, 8539, 8545, 8550, 8553, 8554, 8561, 8562, 8566, 8567, 8568, 8569, 8570, 8572, 8576, 8578, 8580, 8611, 8615, 8616, 8617, 8619 (2), 8630. **May–Jun 2004:** 8648, 8660, 8666, 8671, 8677, 8679, 8689, 8708, 8715, 8730, 8767. **Aug–Sep 2004:** 8845, 8852. **May–Jun 2005:** 8923, 8931, 8977, 8981, 8993\*.

**5. *Crataegus douglasii*****a)** non-JBP specimens (11):

**Alberta:** Cypress Hills Prov. Park, Nicholls Spring, 27 Jul 1945, *Cormack, R.G.H.* 304a (ALTA), S side of Cypress Hills, ca. 6 km S of Elkwater, plateau, south slope, 16 Aug 1995, *Macdonald, I.D.* 950816a1 (ALTA). **Saskatchewan:** Swift Current District 20 mi S & 5 W of Swift Current, 06 Aug 1952, *Boivin, B. & Alex, J.F.* 10067 (USAS). 5 mi NE of Fort Walsh, W block of Cypress Hills, near road to Fort Walsh Historic Site, 06 Jul 1981, *Ledingham, G.F.* & Naturalist Class 7477 (USAS). Cypress Hills Park, no locality, 25 Jul 1948, *Ledingham, G.F.* 48-687 (USAS). Cypress Hills Park, centre block, 30 Aug 1990, *de Vries, B.* in USAS 278090. Cypress Hills Prov. Park, Centre Block, S of Loch Lomond, E of Ben Vannock Drive, 20 Sep 1984, *Ledingham, G.F.* 8923, (USAS). Cypress Hills Prov. Park, Centre Block, along beaver-ponded stream(s) of Loch Lomond, 10 Jul 1986, *Harms, V.L. & R.M.* 36343 (CAN). Cypress Hills Park, no locality, 14 Jul 1947, *Breitung, A.J.* 4776 (ALTA). Cypress Hills Park, no locality, 13 Jul 1947, *Breitung, A.J.* 4733 (ALTA). Cypress Hills, W block, 32 mi SW of Maple Creek, Univ. Regina Field Station, 12 Jun 1973, *Ledingham, G.F.* 5388 (USAS).

**b)** JBP numbers (3\*, 13):

**Aug–Sep 2001:** 8240, 8242, 8245. **May–Jun 2003:** 8500. **Aug–Sep 2003:** 8552, 8612. **May–Jun 2004:** 8670, 8698, 8699, 8705, 8743, 8764\*. **Aug–Sep 2004:** 8853. **May–Jun 2005:** 8962\*, 8964\*, 8983.

**6. *Crataegus macracantha*****a)** non-JBP specimens (0).**b)** JBP numbers (4\*, 16):

**May–Jun 2003:** 8494, 8502. **Aug–Sep 2003:** 8541, 8551, 8575, 8609. **May–Jun 2004:** 8649, 8652, 8667 (2), 8675, 8703. **Aug–Sep 2004:** 8830\*, 8862, 8874, 8888. **May–Jun 2005:** 8919, 8954, 8965\*, 8997\*, 9017\*.

**7. *Crataegus purpurella*****a)** non-JBP specimens (5):

**Saskatchewan:** Cypress Hills Prov. Park, Center Block, along beaver-ponded stream(s) of Loch Lomond, 10 Jul 1986, *Harms, V.L. & R.M.* 36370 (DAO, SASK); same date and locality, *Harms, V.L. & R.M.* 36371 (SASK). Cypress Hills, no locality, 16 Jun 1964, *Newsome, R.D.* 386-64 (DAO). Cypress Hills Prov. Park, Loch Lomond, E side of dam spillway, 09 Jun 2004, *Nagel-Hisey, M. & Goett, R.* 3 (UWO). Cypress Hills Prov. Park, Centre Block, vicinity of Loch Lomond, 09 Jun 2003, *Nagel-Hisey, M.* 2 (UWO). Cypress Hills Prov. Park, Loch Lomond, E side of dam spillway, 09 Jun 2004, *Nagel-Hisey, M. & Goett, R.* 2 (UWO).

**b)** JBP numbers (0\*, 41):

**Aug–Sep 2001:** 8248, 8251, 8252. **May–Jun 2003:** 8490, 8495, 8499. **Aug–Sep 2003:** 8555, 8557, 8558, 8559, 8610, 8610a, 8620. **May–Jun 2004:** 8653, 8674, 8686, 8690, 8697, 8707, 8742, 8747. **Aug–Sep 2004:** 8700, 8856, 8858, 8860, 8867, 8869, 8870, 8872, 8873, 8878, 8883, 8892. **May–Jun 2005:** 8927, 8928, 8929, 8938, 8955, 8984, 8985, 8988.

**8. *Crataegus rivuloadamensis*****a)** non-JBP specimens (5):

**Alberta:** Cypress Hills, W slope, in coulees, 13 Aug 1947, *Breitung, A.J.* 5502 (DAO). W side of Cypress Hills, side of coulee, 27 Apr 1952, *Moss, E.H.* 10089 (ALTA, CAN). **Saskatchewan:** Cypress Hills Prov. Park, Fort Walsh, 20 Aug 1947, *Breitung, A.J.* 5704 (DAO). Cypress Hills Prov. Park, Loch Lomond, E of dam spillway, 09 Jun 2004, *Nagel-Hisey M. & Goett R.* 1b (UWO). Cypress Hills Prov. Park, Loch Lomond, E of dam, 09 Jun 2004, *Nagel-Hisey M. & Goett R.* 1a (UWO).

**b)** JBP numbers (21\*, 11):

**Aug–Sep 2001:** 8222\*, 8223\*. **May–Jun 2003:** 8512\*. **Aug–Sep 2003:** 8516\*, 8518\*, 8544, 8548, 8556, 8627, 8631. **May–Jun**



**2004:** 8722\*, 8734, 8737, 8749, 8752, 8762\*, 8763\*, 8765\*, 8766\*, 8768\*, 8777\*, 8782\*, 8805\*. **Aug–Sep 2004:** 8805\*, 8807\*, 8808\*, 8811\*, 8832\*, 8837\*, 8843\*, 8868, 8900.

### 9. *Crataegus rivulopugnensis*

**a)** non-JBP specimens (1):

**Saskatchewan:** Cypress Hills, W block, ¼–1½ km SE of AB border, 23 Jun 2003, *Harms, V.L.* 44174 (SASK).

**b)** JBP numbers (23\*, 12):

**Aug–Sep 2003:** 8517\*, 8520\*, 8533, 8542, 8628, 8629, 8632\*. **May–Jun 2004:** 8728\*, 8748, 8760, 8771\*. **Aug–Sep 2004:** 8793\*, 8800\*, 8802\*, 8806\*, 8809\*, 8827\*, 8835\*, 8836\*, 8839\*, 8840\*, 8842\*, 8877, 8895, 8908. **May–Jun 2005:** 8973, 8976, 8992\*, 8994\*, 8996\*, 8999\* (2), 9004, 9005\*, 9007\*, 9008\*.

### 10. *Crataegus rubribracteolata*

**a)** non-JBP specimens (4):

**Alberta:** SE Alberta, Manyberries, 12 Jul 1935, *Moss, E.H.* 3270 (ALTA). Cypress Hills Park, up Suicide Coulee, Suicide Creek, E of Elkwater P.O., 13 Jul 1945, *Cormack, R.G.H.* 46512 (ALTA). **Saskatchewan:** ca. 10.1 mi S of Maple Creek, near bridge crossing Maple Creek (stream) off Hwy. #21, 10 Jul 1969, *Zubrowski, S.J.* 225 (DAO). SE of Tompkins, 20 May 1969, *Looman, J.* 12180 (SASK).

**b)** JBP numbers (13\*, 33):

**Aug–Sep 2001:** 8217a\*. **May–Jun 2003:** 8497. **Aug–Sep 2003:** 8540, 8560, 8564, 8565, 8573, 8623, 8624, 8625. **May–Jun 2004:** 8636\*, 8645, 8647, 8658, 8659, 8663, 8668, 8673, 8676, 8678, 8680, 8688, 8709, 8713, 8719\*, 8720\*, 8721\*, 8728a\*, 8732, 8780\*, 8781\*. **Aug–Sep 2004:** 8798\*, 8801\*, 8820\*, 8821\*, 8834\*, 8849, 8850, 8851, 8852, 8854, 8864, 8896, 8903. **May–Jun 2005:** 8950, 8986

### 11. *Crataegus sheila-hippsiae* var. *saskatchewanensis*

**a)** non-JBP specimens (1):

**Saskatchewan:** Cypress Hills Prov. Park, along trail into Lone Pine Campground, E of Ben Vannock Dr., Centre Block, S of Loch Lomond, 20 Sep 1984, *Ledingham, G.F.* 8922 (USAS).

**b)** JBP numbers (0\*, 22):

**May–Jun 2003:** 8486. **Aug–Sep 2003:** 8577. **May–Jun 2004:** 8646, 8651, 8654, 8655, 8664, 8682, 8696, 8740. **Aug–Sep 2004:** 8848, 8859, 8861, 8864, 8865, 8879, 8889, 8891, 8893 (2). **May–Jun 2005:** 8924, 8940, 8956.

### 12. *Crataegus sheridana*

**a)** non-JBP specimens, including all specimens at UWO from outside Cypress Hills (18): [Note that a large number of the cited records are from cultivated plans in North Dakota. As these have very reliable provenances they have been arranged according to their source states and counties.]

**Minnesota:** Big Stone Co.: 3.5 mi SE of Ortonville, Big Stone NWR, 6 Jun 1997, *W.R. Smith* 26583 (UWO); same loc., 22 Sep 1997, *W.R. Smith* 26877 (UWO).

**North Dakota:** Seed from North Dakota, Sheridan Co., cultivated North Dakota, Burleigh Co., E of Bismarck, 01 Oct 1993, *Knudson, M.* 9005841 (UWO). Seed from North Dakota, Sheridan Co., cultivated North Dakota, Burleigh Co., E of Bismarck, 01 Jun 1993, *Knudson, M.* 9005841 (UWO). **Saskatchewan:** Maple Creek, 14 Jul 1947, *Breitung, A.J.* 4875 (DAO). Cypress Hills, Birch Creek Ranger Station, 15 Jul 1947, *Breitung, A.J.* 4857 (ALTA, DAO). Ravenscrag, fossil site, 10 Oct 1987, *Lepage, B.* 144 (SASK). Swift Current, 26 May 1936, *Bolton, J.L.* in SASK 111550. **South Dakota:** Seed from South Dakota, Butte Co., 1 mi S of Castle Rock Butte, cultivated North Dakota, Burleigh Co., E of Bismarck, 22 May 1991, *Knudson, M.* 9005839 (UWO). Seed from South Dakota, Day Co., cultivated North Dakota, Burleigh Co., E of Bismarck, ?? Oct 1989, *Knudson, M.* 9034984 (UWO). Seed from South Dakota, Day Co., cultivated North Dakota, Burleigh Co., E of Bismarck, 01 Oct 1993, *Knudson, M.* 9005797 (UWO). Seed from South Dakota, Day Co., cultivated North Dakota, Burleigh Co., E of Bismarck, 01 Jun 1993, *Knudson, M.* 9005797 (UWO). Seed from South Dakota, Dueul Co., cultivated North Dakota, Burleigh Co., E of Bismarck, 21 May 1993, *Knudson, M.* 9005778 (UWO). Seed from South Dakota, Dueul Co., cultivated North Dakota, Burleigh Co., E of Bismarck, 01 Oct 1993, *Knudson, M.* 9005778 (UWO). Seed from South Dakota, Marshall Co., cultivated North Dakota, Burleigh Co., E of Bismarck, 01 Oct 1993, *Knudson, M.* 9005850 (UWO). Seed from South Dakota, Hamlin Co., E side of L. Poinsett, cultivated North Dakota, Burleigh Co., E of Bismarck, 22 May 1991, *Knudson, M.* 9005798 (UWO). Seed from South Dakota, Marshall Co., cultivated North Dakota, Burleigh Co., E of Bismarck, 01 Jun 1993, *Knudson, M.* 9005850 (UWO). Seed from South Dakota, Marshall Co., cultivated North Dakota, Burleigh Co., E of Bismarck, 01 Jun 1993, *Knudson, M.* 9005849 (UWO). Seed from South Dakota, Marshall Co., cultivated North Dakota, Burleigh Co., E of Bismarck, 01 Oct 1993, *Knudson, M.* 9005849 (UWO). **Wyoming:** Seed from Wyoming, Crook Co., cultivated North Dakota, Burleigh Co., E of Bismarck, 01 Oct 1993, *Knudson, M.* 9034980 (UWO). Seed from Wyoming, Crook Co., cultivated North Dakota, Burleigh Co., E of Bismarck, 20 May 1993, *Knudson, M.* 9034980 (UWO). Crook Co., Black Hills, along Inyan Kara Cr. ca. 5 air mi E of Keyhole Reservoir, ca. 15 air mi W of Sundance, 18 Sep 1984, *Nelson, B.E.* 12108 (UWO).

**b)** JBP numbers (1\*, 22):

**Aug–Sep 2003:** 8492, 8574. **May–Jun 2004:** 8669, 8672, 8687, 8706, 8756. **Aug–Sep 2004:** 8718\*, 8736, 8745, 8866, 8875, 8886, 8902, 8909. **May–Jun 2005:** 8918, 8920, 8921, 8941, 8952, 8958, 8970, 8974.



**13. *Crataegus ursopedensis*****a)** non-JBP specimens (1):**Saskatchewan:** Skull Creek, 12 Jun 1969, Looman, J. 12520 (SASK). Cypress Hills, Piapot, 08 Sep 1937, Bolton, J.L. in SASK 111549.**b)** JBP numbers (8\*, 25):**Aug–Sep 2003:** 8534, 8563 (4), 8621. **May–Jun 2004:** 8717\*, 8729\*, 8731, 8735, 8757, 8779\*. **Aug–Sep 2004:** 8818, 8828\*, 8829\*, 8847, 8857, 8876, 8890, 8904, 8905, 8910, 8911, 8913. **May–Jun 2005:** 8711, 8922 (2), 8930, 8939 (2), 8951 (3), 8959, 8968, 8972, 8987, 9000\*, 9001\*, 9009\*.**13a. *Crataegus* "Brett Gaff"****a)** non-JBP specimens (0).**b)** JBP numbers (3\*, 18):**May–Jun 2003:** 8492a. **May–Jun 2004:** 8637, 8665, 8695, 8701, 8726\*, 8733, 8751, 8759. **Aug–Sep 2004:** 8813\*, 8833\*, 8863, 8884, 8887, 8898. **May–Jun 2005:** 8926 (2), 8934, 8935, 8937, 8939, 8979.

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